PHYSICAL TASKS OF MILITARY OCCUPATIONAL SPECIALTIES AS RISK FACTORS FOR DISABLING KNEE INJURY

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CHAPTER I

INTRODUCTION

It is important to perform research on injuries for both fiscal and humanistic reasons. Injuries are the fourth leading cause of death in Americans of all ages[1] and the leading cause of death in persons under the age of 44.[2] Although injuries are a leading cause of death, many individuals live permanently with the outcome of an injury. These disabling injuries can be expensive, as indicated by the United States Army estimates. The U.S. Army estimated that the fiscal impact of physical disability in the Army in 1994 was 500 million dollars for disability payments alone, and this figure did not include medical treatment or salary and benefit costs while the soldier was on "no duty or limited duty" status.[3] Furthermore, the human costs of injuries are inestimable.

Besides the fiscal impact of injuries, human lives are affected. Injured individuals experience some level of suffering, and if severe enough, family and friends suffer as well. Even if the physical pain is minor, an injury can inhibit lifestyle and if movement is impaired, it may be difficult to perform daily tasks. Also, injured individuals or family members may experience emotional pain through a loss of a life, loss of a limb, lost time on the job, lost wages, or loss of a job. With further research, the risk factors for injury could be determined, which in turn could lead to a reduction of injuries and their consequences through prevention.

Many injuries are associated with occupation,[4, 5] but comprehensive databases for research are not always easily accessible. One such database is the Total Army Injury and Health Outcomes Database (TAIHOD) maintained by the US Army Research

Institute of Environmental Medicine (USARIEM) in Natick, Massachusetts.[6] The USARIEM falls under the U.S. Army Medical Research and Material Command (USAMRMC); which has a research mission of studying military medical problems of importance to national defense.[6]

In particular, the Army recognized the need to perform research on women, since less has been done and they currently comprise 14% of the active military. To support this research. Congress appropriated $40 million dollars for the Defense Women's Health Research Program (DWHRP). Then the DWHRP funded the USARIEM's research proposal entitled "The Impact of Injuries on the Health and Readiness of Women in the Army from 1980-1994." This project was designed to investigate injuries among women in the Army using data combined from a variety of Army and Department of Defense sources to make one relational database. This database is called the Total Army Injury and Health Outcomes Database (TAIHOD).[6] Since this database was funded through the DWHRP, the focus has been on women, but men have always been included in the database as well.

The TAIHOD links six databases (Table 1.1) and has information on approximately 2.5 million current and former active duty personnel,[6] of which about 11.8% are women,[7] so the power for analytic epidemiology studies of many specific injuries is adequate. Since the occupational data are linked to health and injury data, this may be a unique resource to study the occupational risks of injury.

The objective of this thesis was to create a system for grouping occupation within the Army, by physical tasks, that would permit meaningful analysis of the relationship between occupation and disabling knee injury. The primary goal was to develop

groupings of military occupational specialties (MOS) according to their defining characteristics. Each military occupation has a MOS associated with it, which includes information on job title, gender requirements, and physical tasks (Table 1.2 and 1.3). There are thousands of MOSs in the Army, some of which have similar physical tasks, which may in turn be associated with risk of injury. These MOSs are available in the TAIHOD for each soldier over the time he or she worked in the Army. The physical task groupings that were developed in this project were physical demand rating, maximum weight lifted, maximum distance ran/walked, time walked, weight lifted and carried, height climbed, hours spent sitting, hours spent standing, amount of kneeling, weight pushed/pulled, and career management field. The secondary goal of this thesis was to determine if the resulting classification scheme was useful in discrimination of the risk of disabling knee injury. Using a case-control design, the specific research question was: Do cases have different physical tasks or demands than controls, based on the MOS description?

Table 1.1. Total Army Injury and Health Outcomes Database (TAIHOD) overview

Defense Manpower Data Center (DMDC)	**Personnel data:** demographic variables, pay files, loss files (arrival and departure information), Gulf War activation files.
Individual Patient Data System (IPDS)	**Hospitalization data**: demographic variables, diagnosis, injury type/cause, bed days, non-army hospitalization.
Army Safety Management Information System (ASMIS)	**Lost-time injury data:** demographic variables, unintentional aviation incidents, unintentional ground incidents, event specific information.
Army Disability Data	**Disabilities:** demographic variables, diagnosis, percentage disability, functional disability codes, work relatedness, case outcomes.
Army Casualty Information Processing System (ACIPS)	**Fatality data:** demographic variables, event specific information, cause of death.
Health Risk Appraisal (HRA)	**Health habits data:** demographic variables, self-reported health habits, physiological measurements.

Table 1.2. Example of military occupational specialty that is open to both genders

MOS	Title	Gender	Physical Demand Rating	Physical Tasks
94B	Food Service Specialist	Open	Heavy	1. Occasionally lifts 100 pounds 2 feet and carries 100 feet as part of a 2 soldier team (prorated 50 pounds). 2. Frequently pushes, pulls, lifts, and carries 50 pounds. 3. Occasionally digs, lifts, and shovels 21 pounds scoops of dirt 3 x 3 feet while bending, stooping, or kneeling. 4. Frequently stands and/or walks for a period of 4 hours duration. 5. Must possess normal color vision 6. Must possess finger dexterity in both hands. 7. Frequently writes to keep records and compile data.

Table 1.3. Example of military occupational specialty that is closed to women

MOS	Title	Gender	Physical Demand Rating	Physical Tasks
11B	Infantryman	Closed to Women	Very Heavy	1. Frequently visually identifies vehicles, equipment, and individuals at long distances. 2. Occasionally raises and carries 160 pounds person on back. 3. Frequently performs all other tasks while carrying a minimum of 65 pounds, evenly distributed over entire body. 4. Frequently digs, lifts, and shovels 21 pounds scoops of dirt in bent, stooped or kneeling position. 5. Must be able to hear oral commands in outdoor area from distances up to 50 meters. 6. Frequently walks, runs, crawls, and climbs over varying terrain for a distance of up to 25 miles. 7. Frequently runs for short distances. 8. Occasionally walks slowly for 2 hours out of 6 while carrying 26 pounds. 9. Frequently gives oral commands in outside area at distances up to 50 meters. 10. Frequently lifts and lowers 32 pounds bags shoulder high. 11. Frequently throws 1 pound object 40meters. 12. Occasionally throws 1 pound object 40 meters. 13. Occasionally climbs a rope a distance of up to 30 feet. 14. Occasionally performs all other tasks while carrying a minimum of 65 pounds evenly distributed over entire body.

CHAPTER II

REVIEW OF LITERATURE

A. Occupational Knee Injuries

Occupational factors are known to be associated with increased knee injuries.[3, 4] For example, there is a higher prevalence of knee disorders in people who kneel or squat at work[4] or who have very heavy physical demands.[3] Physical tasks of kneeling are used in MOS descriptions (Tables 1.2 and 1.3). One such task of an infantryman is stated as "frequently digs, lifts, and shovels 21 pound scoops of dirt in bent, stooped or kneeling position" (Table 1.3).

Knee injuries are also associated with certain sports, such as professional or recreational volleyball, soccer, basketball and rugby.[5, 8] One study showed injuries in volleyball players to be associated with physical movements such as planting and cutting, straight-knee landing, and one-step stop landing with knee hyperextended.[5] Another study showed sports with contact, such as rugby, to have higher levels of knee injuries than non-contact sports.[8] Physical task descriptions such as running are also used in the MOS (Tables 1.2 and 1.3). For example, "frequently walks, runs, crawls, and climbs over varying terrain for a distance of up to 25 miles" is a task of an infantryman (Table 1.3).

B. Gender

Many studies have shown differences in frequency and types of knee injuries between men and women. For example, it has been reported that women athletes injure

their knees more than men athletes, especially the anterior cruciate ligament (ACL).[5, 9-11] This may be due to physical differences between the genders. Women, on the average, are shorter, have wider hips and narrower shoulders, have shorter legs and arms, and are weaker in lower and upper body strength than men.[10, 12-15] Furthermore, women have a different shaped femur notch through which the ACL runs, a slope in the knees from wider hips, and tend to have looser joints.[10]

C. Military Studies

One of the earliest articles on the risk of injury to soldiers was published in 1983. It was a descriptive review of injuries in the lower extremities associated with running, jogging, and marching.[16] Prior physical condition, physical anomalies, body weight, previous injury, gender, training surface, footwear, and training techniques were found to influence the incidence of injuries. The author stated that too much running, marching, or weight lifting without proper recovery could lead to injury.

In 1987, a case-control study was published on the risk of injury in soldiers.[17] Cases were soldiers with new injuries presented for medical care for the first time. Controls were a random sample of uninjured soldiers at the same medical facilities. A potential selection bias in this study may have influenced results since any soldier who did not come to the medical center would not be included in the study. The results indicated that risk factors for injury included age, gender, unit of assignment, location of housing, and amount of weekly exercise. Also, combat units had higher injury rates than non-combat units. This finding, along with the increased risk with amount of exercise,

suggests that injuries are related to physical tasks, including those required to perform certain military jobs.

Since the 1980s several studies have been performed on basic military training in the Army.[18-20] Jones et al. followed a cohort of Army Infantrymen were followed over 12 weeks of training.[18] They were given baseline and follow-up evaluations. The data on demographics, background, and job activity levels were obtained via a questionnaire. The data on physical fitness were obtained via measurements of body mass index, height, weight, neck and wrist girths, flexibility, a 2-mile run, sit-ups, and push-ups. Injury cases were defined as any individual recorded as having treatment for one or more lower extremity musculoskeletal injuries, such as strains, sprains, stress fractures, and tendonitis. A statistically significant increased risk was found between musculoskeletal injury and increased age, smoking, and top fifth and bottom fifth percentile of flexibility. There was a non-statistically significant association between musculoskeletal injury and distance run. No association was found between these injuries and previous job activity.

Jones et al. may not have found an association between musculoskeletal injury and job activity levels due to the source of information. Job activity level was self-reported as moderate to heavy, light, or very light. This information is based on perception and it is related to physical fitness. The same job activity level may be rated higher by a less physically fit person than a more physically fit person, possibly introducing misclassification.

When two training units which differed in amount of running were compared, Jones et al. found a non-statistically significant association between musculoskeletal injuries and running.[18] The unit that ran more miles had an odds ratio for

musculoskeletal injury of 1.6 (95% CI: 0.9-2.7) compared to the other unit. Although not statistically significant, this finding suggests that amount of running could be a possible risk for musculoskeletal injuries.

In 1994, another study followed a cohort of infantry training, but over one year instead of 12 weeks.[19] Potential risk factor data, such as smoking history and past running injuries were collected via a questionnaire. As in the previous study,[18] body weight, height, body mass index, flexibility, and strength were measured. Baseline physical fitness was assessed via the Army Physical Fitness Test (APFT) which measures the number of sit-ups performed in 2 minutes, number of push-ups completed in 2 minutes, and the total time to complete a 2-mile run. Injuries were defined as any clinical visit for a traumatic or overuse injury occurring during the one year period of time. A training injury was defined as any musculoskeletal complaint that resulted in a clinic visit and that was suspected to have been caused by physical training. Specifically, overuse injuries were musculoskeletal injuries caused by repetitive motion and associated with running and marching, such as tendonitis, patellofemoral syndrome, and stress fractures.

Reynolds et al. found that 55% of soldiers experienced one or more injuries.[19] Eighty-eight percent of these injuries were attributed to physical training or vigorous operational activities. The five most common injuries were sprain, musculoskeletal pain, strain, tendonitis, and other overuse injuries. Ninety-two percent of the training-related overuse injury clinic visits involved the lower extremities and lower back. Feet were the most commonly affected (20.8%), followed by the knee (17.6%). The soldiers who had 2-mile run times in the slowest quartile had the highest incidence of low-back and lower

extremity injuries and there was a dose-response relationship between number of cigarettes smoked per day and these injuries.

In another study of injuries during basic military training, a case-control study design was used.[20] Cases were defined as having a musculoskeletal injury during the basic training course that was severe enough to be delayed in finishing the course. Control subjects were randomly selected from recruits without such injury during the same period of study. Statistically significant associations with odds of injury were found between female gender, body mass index >26.9, winter training, a history of lower limb injury, and presence of lower limb deformity. No association was found for height, weight, age, smoking, or the male to female ratio of individuals in the course.

These results strengthen the need to elucidate the effect of gender when performing case-control studies of injury. Also, the risk factors identified in past studies, such as season in which the soldier became disabled and presence of previous injury should be included in future studies as potential confounders.

A historical cohort study was performed on infantry soldiers assigned to a battalion in Alaska. Subjects were male soldiers assigned to this battalion. Physical fitness was determined by the APFT. Injury data were collected from a review of the soldiers' medical treatment records for the six months prior to the APFT. An injury was defined as any acute, overuse, or traumatic event transcribed in the medical record during the six-month period. The first visit for a specific injury was used as a marker for a new injury. Injuries were divided into two categories, musculoskeletal and all other injuries. Knees ranked third in injury rates, with 10.4% of musculoskeletal injuries and 1.4% of all other injuries.

There was no difference in musculoskeletal injury or all other injury incidence among the three age groups.[21] Significant differences were found between physical fitness, as determined by the APFT, and musculoskeletal injuries. Soldiers in the slowest quartile for the 2-mile run were 1.6 times more likely to have been injured than subjects in the fastest quartile. Soldiers in the quartile performing the lowest number of sit-up repetitions in 2 minutes were 1.9 times more likely to have been injured than subjects in the quartile performing the most repetitions. There was not a significant relationship between push-ups repetitions and musculoskeletal injury.

Other military studies have specifically used physical descriptions of MOSs as risk factors for injury [3] or pregnancy induced hypertension. [22] For example, one study found that MOSs in the Army most associated with musculoskeletal disability were characterized as having moderately heavy, heavy, and very heavy physical job demands based on MOS description.[3]

In another report, a retrospective cohort study of pregnancy-induced hypertension and occupation was performed among Navy personnel.[22] The investigators grouped occupations based on exposure definitions (Table 2.1). These are more specific categories than described in the previous example,[3] which simply had broad physical demand groups. This study used the Retrospective Case-Mix Analysis System (RCMAS) for the outcome based on hospital discharge data.[22] This is a component of the Defense Medical Information System. The demographic data were obtained by matching social security numbers to the database maintained by the Defense Manpower Data Center. The job classification was determined by a code (name not given) in the Defense Manpower Data Center. An increased risk of transient gestational hypertension was found for jobs

requiring high levels of standing, medium levels of physical exertion and lifting. Although this is not a study of injury, it is an example of grouping occupational physical tasks as risk factors for a specified outcome.

In summary, the literature supports associations between occupational physical tasks and injuries. In particular, kneeling, squatting, running, marching, and physical demand rating were indicators of injury in previous epidemiologic studies. Furthermore, knees were often injured in the studies on musculoskeletal injuries. This information helped form the objective of the current study, which was to create military occupational specialty groups based on physical tasks and to assess any association with disabling knee injuries in a case-control study.

CHAPTER III

METHODS

A. TAIHOD Case-Control Study

The TAIHOD is currently being used in an occupational case-control study by Sulsky et al.[7] to assess risk factors for occupational knee injuries in the US Army, of which this thesis was a part. The cases are all soldiers disabled between 1980-1994 defined by eleven Veterans Administration System for Rating Disabilities (VASRD) codes (Table 3.1). These VASRD codes were directly related to a knee disability that resulted in discharge and were chosen with the help of a military physician.[23] The disability file had 860 women and 7868 men who met this definition.

Controls were chosen by a density sampling approach, stratified by gender and year of disability of cases. The controls were individuals without a knee disability matched to year of the case injury. Six female controls for each female case and 1.5 male controls for each male case were chosen. This established the data library, from which all of the female cases and a random sample of 1005 male cases were chosen (67 cases per year). Also from the data library, three controls per case were chosen, stratified by gender. This double extraction method was used to obtain a relatively small but reasonably representative sample for a pilot study (Figure 3.1). This yielded 7454 individuals, representing 1005 cases and 3009 controls among males and 860 cases and 2580 controls among females. These comprise the sample for this thesis.

B. MOS Variables

The physical tasks descriptions used to make the physical task groupings came from the Military Occupational Specialties (MOS) descriptions.[24] The U.S. Army has two types of MOSs for each individual, the primary MOS and the duty MOS. The primary MOS (PMOS) is the occupation for which the soldier is trained. The duty MOS (DMOS) is the occupation that the soldier performs. The TAIHOD has information on both DMOS and PMOS for each soldier at six month intervals. Preliminary analysis was performed on DMOS and PMOS to determine which one would be used in this study (Table 3.2 and 3.3).

The DMOS at year of disability was chosen first as the MOS of choice because it was the occupation that the soldier performed during the year in which the injury occurred. Frequency distributions for both men and women were computed. Men had 12.3% missing data and women had 20.9% missing data, and cases were more likely to have missing DMOS: for male cases had 18.3% missing, while controls had 10.2% missing. Female cases had 32.6% missing, while controls had 17.0% missing.

Since a considerable percentage of data was missing for DMOS at year of disability, and varied based on case-control status, the PMOS at year of disability was analyzed. Only nine individuals (0.1%) were missing this PMOS. Next, the association was found between PMOS at year of disability and DMOS at year of disability for individuals with both of these variables. A high percentage of these men (91.9%) and these women (93.2%) had the same MOS for these variables. Therefore, PMOS had a lower percent missing than DMOS and it was a strong indicator of DMOS when both variables were present in a given year.

Next, DMOS history was assessed for the 492 men (12.3%) and the 720 women (20.9%) with missing DMOS at year of disability. The DMOS histories were printed and reviewed by hand to find the last DMOS before the year of disability. Of the 492 men, 106 (19.1%) had a DMOS before year of disability. This DMOS matched the PMOS at year of disability for 88.7% of the 106 men who had a DMOS recorded before year of disability. Of the 720 women, 83 (11.5%) had a DMOS before year of disability. This DMOS matched the PMOS at year of disability for 75.9% of the 83 women who had a DMOS recorded before year of disability.

Since only about 12% of the individuals with missing DMOS at year of disability had any DMOS recorded before that year, the DMOSs after year of disability were thoroughly reviewed for the 386 men and 637 women that had no DMOS recorded up to year of disability. As expected, very few cases had information on DMOS after year of disability because cases were defined as an individual with a knee injury that led to disability and discharge. Therefore, controls were used to assess if PMOS at year of disability matched the DMOS in the following year. Of the 237 male controls with no DMOS up to year of disability, 156 (65.8%) had a DMOS in the following year that matched PMOS in year of disability. Of the 383 female controls, 196 (51.2%) had a DMOS in the following year that matched PMOS in year of disability.

In summary, a considerable proportion of participants had missing data for DMOS at year of disability, but very few were missing data for PMOS at year of disability. Over 90% of those with both of these variables had the same MOS recorded. For those individuals with missing DMOS at year of disability, the last DMOS before year of disability matched the PMOS at year of disability for more than 75% of the

soldiers. For controls without any DMOS before year of disability, the DMOS in the following year matched the PMOS in year of disability more than 50% of the time.

These results led to the decision that PMOS at year of disability would be used for all subsequent analysis. This is the occupation for which the soldier was trained to perform rather than the duty occupation. The descriptive analysis showed that PMOS is a strong correlate for the DMOS in that year.

C. Physical Task Groupings

All analyses were stratified by gender since many jobs are closed to women and the population for this study was selected by gender. The PMOSs in the TAIHOD are represented by a four-digit code, with the first 3 digits representing the occupation and the last digit representing skill level. Only the first three digits were used in this study. There were 347 different 3-digit PMOSs for men and 259 for women, therefore only the top 50 for each gender were used to make groupings based on job tasks. Frequency distributions of the controls were used to determine the 50 most common PMOSs for each gender (Tables 3.4 and 3.5). Control frequencies were chosen because controls should theoretically represent the experience of the general enlisted U.S. Army population. The individuals in these top PMOSs comprised the new dataset for this project.

After determining the top 50 PMOSs for each gender, it became clear that many of the PMOSs had become obsolete and the physical task descriptions could not be obtained. Changes in MOSs were found in Table B-2: MOS Deletions/Conversions in the Military Occupational Classification and Structure Manual.[24] When the obsolete

MOS was reassigned one new MOS, the change was made in the dataset. When the obsolete MOS was reassigned as two new MOSs, the obsolete MOS was given the most common new MOS. In these cases, the most common MOS was based on control frequency after all other changes had been made. Table 3.6 shows all the changes that were made. All subsequent analyses were based on the dataset after these changes.

Categories for grouping PMOSs, and therefore individuals, were based on the literature review and a thorough review of the physical task descriptions for each PMOS considered. Information for the groupings was abstracted from the physical task descriptions and input as new variables into the dataset. These groupings included physical demand rating, maximum weight lifted, maximum distance ran/walked, maximum time walked, weight lifted and carried, climbing, pushing/pulling, standing, sitting, kneeling, and career management field (Table 3.7).

1. Physical Demand Rating

The U.S. Army assigns physical demand ratings to each MOS. Physical demand ratings are based on upper body strength, with the purpose of classifying each MOS by the amount of physical activity that is required under combat conditions. The categories are very heavy, heavy, moderately heavy, medium, light, and not applicable. These were input as numbers 1-6 into the database for each PMOS as the variable DEMAND. These categories are defined in Table 3.8.

2. Maximum Weight Lifted

The maximum amount of weight lifted in pounds was extracted from the MOS descriptions and input into the database as the variable MAXLIFT. After the data were input, groups of 25 pound increments ranging from 0-175 pounds were developed. The category of 'raises 237 pounds from a horizontal to vertical position' did not fit into this grouping scheme. This was obviously the maximum amount lifted for this PMOS, but the actual weight lifted could not be assessed.

3. Maximum Distance Ran/Walked

This grouping scheme was developed from the maximum amount of running/walking in the physical task descriptions for each MOS. Many of the MOSs had distances given in feet or miles, which were input into the database as the variable MAXFEET. The distances ranged from 0-25 miles. After a frequency distribution was performed eight categories were made. These categories were none, 1-25 feet, 25-50 feet, 51-100 feet, 101-500 feet, 0.25-1.0 miles, 3.0 miles, and 25 miles. Other PMOSs did not have precise distances in the physical task descriptions, but it was clear that 'none' was inappropriate since movement was taking place. These categories were carries, pivots, short distance, and long distance.

4. Maximum Time Walked

The maximum time walked grouping scheme was defined by choosing the amount of walking defined as time in hours and adding it to the database as the MAXTIME variable. The three categories were 2 of 6 hours, 4 hours duration, and none.

5. Lift and Carry

This grouping scheme was developed to incorporate the dual effects of lifting weight and carrying it some distance. This was not accounted for in Maximum Weight Lifted or Maximum Distance Ran/Walked, which were assessed independently without consideration of each other.

The physical task descriptions were reviewed to determine the task for each MOS that incorporated both lifting and carrying. When more than one task had both lifting and carrying, the following rules applied. First, the task involving lifting the heaviest weight was chosen. Second, if there was more than one task with this weight, the longest distance was chosen.

When there was no task with both lifting and carrying, the following rules applied. First, the task with the heaviest weight was chosen. Second, if there was no lifting and carrying and no weight lifted, then the task with the longest distance ran/walked was chosen. Third, if there was no lifting or carrying, 'no lift/no carry' was designated. These categories were made because it did not seem appropriate to include PMOSs with tasks that had either lifting or carrying in the same category with PMOSs that had neither.

The information on lifting and carrying were input as two variables, which were called LIFT and CARRY. The two variables were cross-tabulated to determine where they overlapped. From this, a grouping scheme was determined in the following way so that it would be easy to understand and duplicate in the future. Lifting was grouped in 25- pound intervals ranging from 0-175 pounds. Carrying was grouped as no carrying,

carries, carries short distance, carries 1-25 feet, carries 26-50 feet, carries 51-100 feet, carries 101-500 feet, carries 0.25-1.0 miles, carries 25 miles, carries long distance, and pivots. The categories for lifting and carrying were cross-tabulated to determine 43 of the 44 final categories that incorporated both lifting and carrying. One category was left alone and did not fit easily into the scheme. This was 'lifts 171 pounds and pivots', which was the only category with any mention of pivoting.

6. Kneeling

Kneeling groups were developed through a review of the PMOS task descriptions for tasks that required any type of kneeling. Seven categories were established and input into the database as the variable KNEEL. These categories were none, kneels to file, kneels for 4 hours duration, kneels for prolonged periods, shovels 10 lb scoops of dirt in kneeling position, shovels 21 lb scoops of dirt in kneeling position, and lifts, pushes, and pulls 50 lbs in bent, stooped, or kneeling position.

7. Climbing

Climbing groups were developed from the physical tasks that described height climbed in feet. These were input into the database as the variable CLIMB. The eight categories were none, 3 feet, 9 feet, 10 feet, 11 feet, 30 feet, 40 feet, 50 feet.

8. Pushing/Pulling

The maximum amount pushed or pulled was chosen from the MOS task descriptions to make this grouping scheme. The amount described was input into the

database as the variable PUSHPULL. There were 19 different categories, which included weights of 30 lbs to 474 lbs, forces of 50 ft/lb to 600 ft/lb, pushing/pulling a wrench, and no pushing/pulling.

9. Sitting

Sitting groups were developed from the physical task of each PMOS that required sitting. It was input into the database as the variable SIT. The five categories were none, 4 hours, 5 hours, 6 hours, and 8 hours duration.

10. Standing

An indicator of standing was developed in the same manner as the rest of these groupings, from the physical task descriptions of the PMOSs. The task for each PMOS that required the most standing was input into the database as the variable STAND. The eight categories were none, 1 hour, 2 hours, 4 hours, 8 hours, stands, stands for extended periods, and stands for prolonged periods. Although the last three categories are vague, it seemed inappropriate to group them under 'none' or with any of the more specific categories.

11. Career Management Field

Career Management Field (CMF) is a two-digit code given to each MOS with the purpose of grouping MOSs in related fields. The MOSs are related to each other so that "soldiers serving in one specialty have the potential abilities and aptitudes for training and assignment in most of the other specialties in that field."[24] The Career Management

Fields and the PMOSs from this study that were grouped together under each CMF are shown in Table 3.9.

D. Stratified Analysis

As mentioned above, all analysis was stratified by gender because many MOSs are closed to women. Further stratification by race and age was performed on all of the groups because preliminary analysis determined that both race and age were effect modifiers. Race was grouped as white and non-white. Age was grouped in quintiles resulting in the five categories of 17-20 years old, 21-22 years old, 23-26 years old, 27-30.35 years old and 30.36-54 years old. Odds ratios and 95% confidence intervals were calculated for all the stratified groups.

SAS[25] was used for all data management, data entry, frequency distributions and cross-tabulations. Epi Info 6.0b[26] was used to calculate odds ratios and 95% confidence intervals. The referent group for all of the grouping schemes was 'none', except for Physical Demand Rating, which had 'very heavy' as the referent category. Very Heavy was used because it was the largest group and was present in both genders.

E. Logistic Regression

Stata[27] was used for all logistic regression modeling in this project. First, dummy variables were created for all categorical variables. Second, univariate models with odds ratios, 95% confidence intervals, p-values, and likelihood ratio tests were calculated. Odds ratios and trends were evaluated to determine which variables would be included in the logistic regression models. Variables were not included in the model if there was no

detectable trend in the odds ratios as the levels of the variable changed or if there was some level of collinearity with another variable. The variables that were excluded because of lack of trend in the odds ratios were maximum distance ran/walked, maximum time walked, and height climbed. The odds ratios for these variables fluctuated up and down as the groups within the category increased, therefore no logical trend was established. The variables that were excluded because of collinearity with another variable were career management field, carry/lift, and physical demand rating. Carry/lift and physical demand rating measured amounts of lifting, which was also measured by maximum weight lifted. They were excluded since maximum weight lifted had a stronger univariate trend. Career management field was excluded because some of the levels fell out of the model when maximum weight lifted was included.

The odds ratios for the other categories were evaluated to determine if groups could be collapsed. Groups were collapsed when it was logical and the odds ratios were similar. Categories were collapsed within the variables of kneeling, sitting, standing, and pushing/pulling. The four new groups of kneeling were prolonged periods or 4 hours duration, while shoveling 10 lbs or 21 lbs, to file, and none. The two new groups of sitting were sitting and no sitting. The two new groups of standing were standing and no standing. The five new groups of pushing/pulling were <130 pounds, ≥130 pounds, any feet per pound of force, pushing or pulling a wrench, and none.

Although univariate models for each gender were assessed separately, the same variables were excluded from both the male model and the female model for parallel reasons. The remaining seven variables were race, age, maximum weight lifted, pushing/pulling, kneeling, sitting, and standing. A full model was calculated and each

variable was removed one at a time to determine the effect on the other variables. A variable was kept in the model if it caused a 20% change in the coefficient of any other variable after removal. Changes in odds ratios were also calculated. After the final model for each gender was established, the fit was calculated using the Hosmer-Lemeshow Goodness of Fit Test.

Table 3.1. VASRD codes used to define cases in the pilot study of the U.S. Army, 1980-1994

VARD Code	Description
5055	knee replacement
5160	thigh amputation: disarticulation with loss of extrinsic pelvic girdle muscles
5161	thigh amputation: upper third, one third of the distance from the perineum to knee joint
5163	leg amputation with defective stump, thigh, amputation recommended
5255	impairment of femur
5256	ankylosis of the knee
5257	other impairment of the knee
5258	semilunar dislocated cartilage with frequent episodes of 'locking' and pain
5259	semilunar removal of cartilage
5262	impairment of the tibia and fibula
5263	genu recurvatum (acquired, traumatic, with weakness and insecurity in weight-bearing objectively demonstrated)

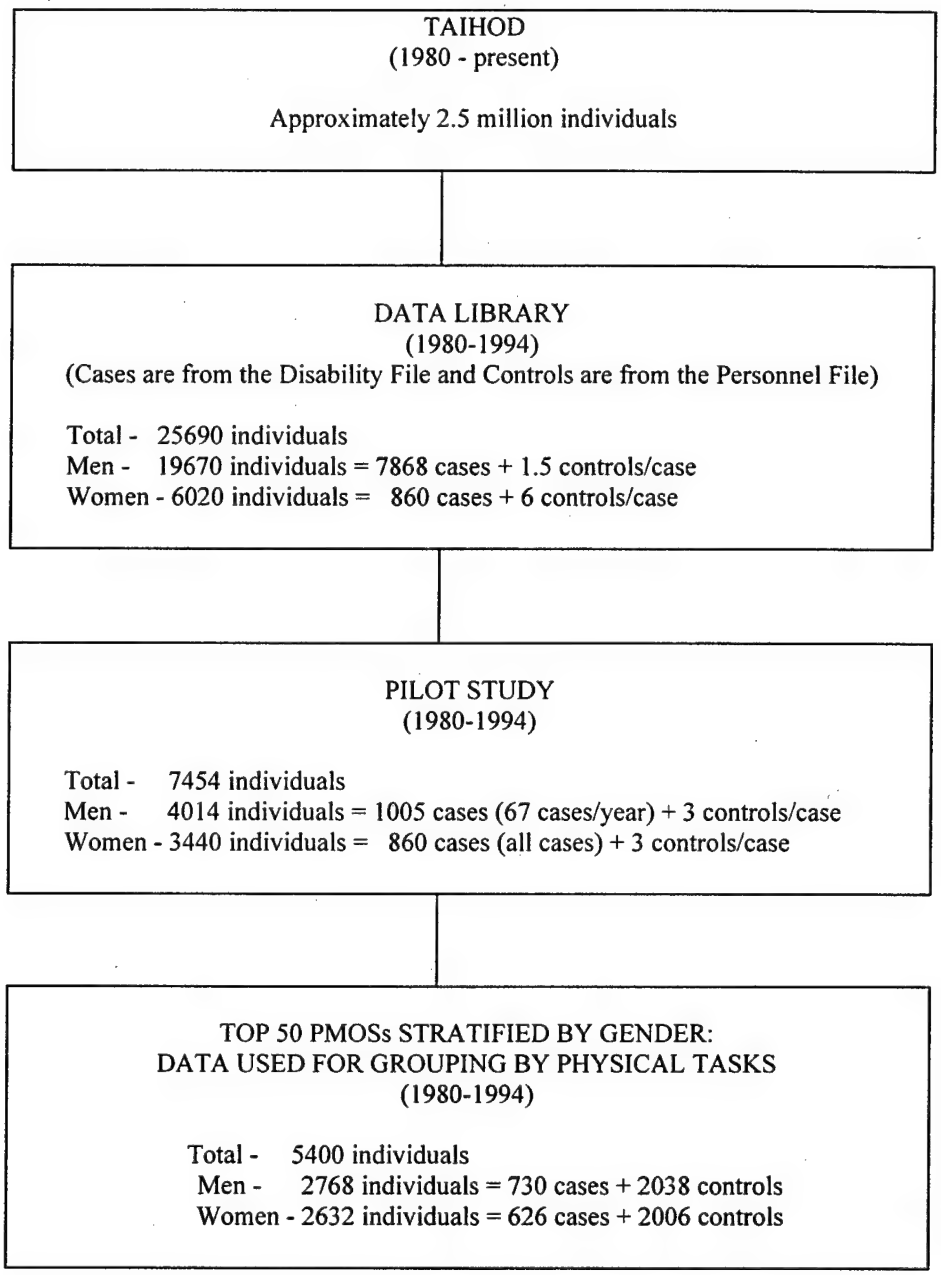

Figure 3.1. Composition of data extraction for study of physical tasks of military occupational specialties as risk factors for disabling knee injuries in U.S. Army, 1980-1994

Table 3.2. Descriptive statistics of individuals in the pilot study with missing DMOS in year of disability (DISYR)

	CASES		CONTROLS	
	n	Percent	N	Percent
TOTAL	464		748	
PMOS in DISYR = past DMOS	53	11.42	104	13.90
PMOS in DISYR ≠ past DMOS	8	1.72	24	3.21
PMOS in DISYR = DMOS in following year	5	1.08	352	47.06
No DMOS in following year or PMOS ≠ DMOS in following year	398	85.78	268	35.83
MEN	184		308	
PMOS in DISYR = past DMOS	30	16.30	64	20.78
PMOS in DISYR ≠ past DMOS	5	2.72	7	2.27
PMOS in DISYR = DMOS in following year	1	0.54	156	50.65
No DMOS in following year or PMOS ≠ DMOS in following year	148	80.43	81	26.30
WOMEN	280		440	
PMOS in DISYR = past DMOS	23	8.21	40	9.09
PMOS in DISYR ≠ past DMOS	3	1.07	17	3.86
PMOS in DISYR = DMOS in following year	4	1.43	196	44.55
No DMOS in following year or PMOS ≠ DMOS in following year	250	89.29	187	42.50

Table 3.3. Descriptive statistics of individuals in the pilot study with both DMOS and PMOS in year of disability (DISYR)

		CASES		CONTROLS	
		n	Percent	n	Percent
TOTAL		1401		4840	
	PMOS in DISYR = DMOS in DISYR	1293	92.29	4477	92.50
	PMOS in DISYR ≠ DMOS in DISYR	108	7.71	363	7.50
MALE		821		2701	
	PMOS in DISYR = DMOS in DISYR	768	93.54	2483	91.93
	PMOS in DISYR ≠ DMOS in DISYR	53	6.46	218	8.07
FEMALE		580		2139	
	PMOS in DISYR = DMOS in DISYR	525	90.52	1994	93.22
	PMOS in DISYR ≠ DMOS in DISYR	55	9.48	145	6.78

Table 3.4. Top 50 PMOSs for control men in the pilot study of the U.S. Army, 1980-1994

	PMOS	MOS Title	Frequency	Percent
*	11B	Infantryman	244	8.1
*	13B	Cannon Crewmember	140	4.7
	63B	Light-Wheel Vehicle Mechanic	110	3.7
	95B	Military Police	107	3.6
	94B	Food Service Specialist	86	2.9
*	12B	Combat Engineer	74	2.5
	76Y	Unit Supply Specialist	66	2.2
	71L	Administrative Specialist	63	2.1
*	19D	Cavalry Scout	62	2.1
	64C	Motor Transport Operator	55	1.8
*	11H	Heavy Antiarmor Weapons Infantrymen	53	1.8
*	11M	Fighting Vehicle Infantrymen	53	1.8
	91B	Medical Specialist	52	1.7
*	19E	M48-M60 Armor Crewman (Reserve Component)	51	1.7
*	19K	M1 Armor Crewman	50	1.7
*	11C	Indirect Fire Infantryman	44	1.5
	91A	Medical Equipment Repairer	44	1.5
	88M	Motor Transport Operator	38	1.3
	31M	Multichannel Transmission Systems Operator	35	1.2
	52D	Power Generation Equipment Repairer	34	1.1
	31C	Radio-Operator Maintainer	33	1.1
*	13F	Fire Support Specialist	28	0.9
	54B	Chemical Operations Specialist	26	0.9
	76C	Equipment Records and Parts Specialist	26	0.9

* Closed to women

Continued, next page.

Table 3.4. continued

	PMOS	MOS Title	Frequency	Percent
	77F	Petroleum Supply Specialist	25	0.8
	31V	UL Communications Maintainer	23	0.8
	76P	Materiel Control and Accounting Specialist	23	0.8
	63H	Track Vehicle Repairer	22	0.7
	63W	Wheel Vehicle Mechanic	21	0.7
	76V	Materiel Storage and Handling Specialist	21	0.7
	62E	Heavy Construction Equipment Operator	20	0.7
	75B	Personnel Administration Specialist	20	0.7
	63S	Heavy-Wheel Vehicle Mechanic	19	0.6
	75Z	Personnel Sergeant	19	0.6
*	16S	Man Portable Air Defense System Crewmember	18	0.6
	36K	Tactical Wire Operations Specialist	18	0.6
*	63T	BRADLEY Fighting Vehicle Systems Mechanic	18	0.6
	00R	Recruiter/Retention NCO	17	0.6
	91C	Practical Nurse	17	0.6
	12C	Bridge Crewmember	16	0.5
	54E	NBC Specialist	16	0.5
	67N	UH-1 Helicopter Repairer	16	0.5
*	13E	Cannon Fire Direction Specialist	15	0.5
	31K	Combat Signaler	15	0.5
	55B	Ammunition Specialist	15	0.5
	72E	Tactical Telecommunications Center Operator	15	0.5
	98G	Voice Interceptor	15	0.5
	96B	Intelligence Analyst	14	0.5
*	16P	CHAPARRAL Crewmember	13	0.4
	52C	Utilities Equipment Repairer	13	0.4

* Closed to Women

Table 3.5. Top 50 PMOSs for control women in the pilot study of the U.S. Army, 1980-1994

PMOS	MOS Title	Frequency	Percent
71L	Administrative Specialist	281	10.9
76Y	Unit Supply Specialist	116	4.5
94B	Food Service Specialist	109	4.2
91A	Medical Equipment Repairer	105	4.1
95B	Military Police	90	3.5
91B	Medical Specialist	82	3.2
76V	Materiel Storage and Handling	62	2.4
63B	Light-Wheel Vehicle Mechanic	56	2.2
75B	Personnel Administration Specialist	56	2.2
31M	Multichannel Transmission Systems Operator	50	1.9
76P	Materiel Control and Accounting Specialist	50	1.9
75D	Personnel Records Specialist	47	1.8
72E	Tactical Telecommunications Center Operator	46	1.8
91C	Practical Nurse	45	1.7
76C	Equipment Records and Parts Specialist	40	1.6
73C	Finance Specialist	39	1.5
88M	Motor Transport Operator	39	1.5
98G	Voice Interceptor	39	1.5
75C	Personnel Management Specialist	37	1.4
64C	Motor Transport Operator	34	1.3
92B	Medical Laboratory Specialist	34	1.2
77F	Petroleum Supply Specialist	30	1.2
91E	Dental Specialist	30	1.1
71G	Patient Administration Specialist	29	1.1

Continued, next page.

Table 3.5. continued

PMOS	MOS Title	Frequency	Percent
75E	Personnel Actions Specialist	28	1.0
31C	Radio Operator-Maintainer	27	1.0
72G	Automatic Data Telecommunications Operator	27	1.0
98C	Signals Intelligence Analyst	27	0.9
71D	Legal Specialist	24	0.9
75Z	Personnel Sergeant	24	0.9
96B	Intelligence Analyst	23	0.8
71M	Chaplain Assistant	20	0.7
71N	Traffic Management Coordinator	19	0.7
91D	Operating Room Specialist	19	0.7
55B	Ammunition Specialist	18	0.7
36C	Wire Systems Installer	17	0.7
74C	Record Telecommunications Operator-Maintainer	17	0.7
52D	Power-Generation Equipment Repairer	16	0.6
76W	Petroleum Supply Specialist	16	0.6
31K	Combat Signaler	14	0.5
91R	Veterinary Food Inspection Specialist	14	0.5
92A	Automated Logistical Specialist	14	0.5
92Y	Unit Supply Specialist	14	0.5
54B	Chemical Operations Specialist	13	0.5
93P	Aviation Operations Specialist	13	0.5
74D	Information System Operator	12	0.5
91P	Radiology Specialist	12	0.5
54E	NBC Specialist	11	0.4
91S	Preventive Medicine Specialist	11	0.4
63H	Track Vehicle Repairer	10	0.4

Table 3.6. Changes made to PMOSs that were obsolete in the July 1995 version of the Military Occupation Classification and Structure Manual[24]

PMOS in Pilot Study	PMOS Title	New PMOS	New PMOS Title
31K	Combat Signaler	31U	Signal Support Systems Specialist
31M	Multi-channel Transmission Systems Operator	31R	Multichannel Transmission Systems Operator-Maintainer
31V	UL Communications Maintainer	31U	Signal Support Systems Specialist
36C	Wire Systems Installer	31L	Cable Systems Installer-Maintainer
36K	Tactical Wire Operations Specialist	31U	Signal Support Systems Specialist
54E	NBC Specialist	54B	Chemical Operations Specialist
64C	Motor Transport Operator	88M	Motor Transport Operator
71N	Traffic Management Coordinator	88N	Transportation Management Coordinator
72E	Tactical Telecommunications Center Operator	74C	Record Telecommunications Operator-Maintainer
72G	Automated Data Telecommunications Operator	74C	Record Telecommunications Operator-Maintainer
74D	Information System Operator	74B	Information Systems Operator-Analyst
76C	Equipment Records and Parts Specialist	92A	Automated Logistical Specialist
76P	Materiel Control and Accounting Specialist	92A	Automated Logistical Specialist
76V	Materiel Storage and Handling Specialist	92A	Automated Logistical Specialist
76W	Petroleum Supply Specialist	77F	Petroleum Supply Specialist
76Y	Unit Supply Specialist	92A	Automated Logistical Specialist
92B	Medical Laboratory Specialist	91K	Medical Laboratory Specialist

Table 3.7. Grouping schemes based on physical task descriptions of PMOSs for the pilot study of the U.S. Army, 1980-1994

Grouping Scheme	Description
Career Management Field (CMF)	Given to each MOS. The MOSs are clustered into a CMF in a way that a soldier has the potential abilities and aptitudes for training and assignment in most of the other MOSs in that CMF.
Climbing	Chosen from the physical task descriptions as the task with maximum height of climbing.
Kneeling	Chosen from the physical task descriptions as the task with any kneeling.
Lift and Carry	Chosen from the physical task descriptions as the task with maximum weight lifted and carried. If more than one task had this weight, the one with the farthest distance carried was chosen.
Maximum Distance Ran/Walked	Chosen from the physical task descriptions as the task with the maximum distance run or walked, irrelevant of weight carried.
Maximum Time Walked	Chosen from the physical task descriptions as the task with the maximum amount of walking as time in hours.
Maximum Weight Lifted	Chosen from the physical task descriptions as the task with the maximum weight lifted, irrelevant of distance carried.
Physical Demand Rating	Given to each MOS by the US Army. This is based on amounts of weight lifted frequently and occasionally.
Pushing/Pulling	Chosen from the physical task descriptions as the task with pushing and/or pulling.
Sitting	Chosen from the physical task descriptions as the task with the maximum time spent sitting.
Standing	Chosen from the physical task descriptions as the task with the maximum time spent standing.

Table 3.8. Categories of physical demand ratings for MOSs in the U.S. Army

Physical Demand Rating	Description
Light	Lift on an occasional basis a maximum of 20 pounds with frequent or constant lifting of 10 pounds.
Medium	Lift on an occasional basis a maximum of 50 pounds with frequent or constant lifting of 25 pounds.
Moderately Heavy	Lift on an occasional basis 80 pounds with frequent or constant lifting of 40 pounds.
Heavy	Lift on an occasional basis a maximum of 100 pounds with frequent or constant lifting of 50 pounds.
Very Heavy	Lift on an occasional basis over 100 pounds with frequent or constant lifting in excess of 50 pounds.

Table 3.9. Career management fields (CMF) and associated PMOSs of the U.S. Army, 1980-1994

CMF	CMF Title	PMOSs	MOS Title
11	Infantry	11B	Infantrymen
		11C	Indirect Fire Infantrymen
		11H	Heavy Antiarmor Weapons Infantrymen
		11M	Fighting Vehicle Infantrymen
12	Combat Engineering	12B	Combat Engineer
		12C	Bridge Crewmember
13	Field Artillery	13B	Cannon Crewmember
		13E	Cannon Fire Direction Specialist
		13F	Fire Sipport Specialist
14	Air Defense Artillery	16P	CAPARRAL Crewmember
		16S	Man Portable Air Defense System Crewmember
19	Armor	19D	Cavalry Scout
		19E	M48-M60 Armor Crewman
		19K	M1 Armor Crewman
31	Signal Operations	31C	Radio-Operator Maintainer
		31L	Cable Systems Installer-Maintainer
		31R	Multichannel Transmission Systems Operator
		31U	Signal Support Systems Specialist
51	General Engineer	62E	Heavy Construction Equipment Operator
54	Chemical	54B	Chemical Operations Specialist
55	Ammunition	55B	Ammunition Specialist
63	Mechanical Maintenance	52C	Utilities Equipment Repairer
		52D	Power Generation Equipment Repairer
		63B	Light-Wheel Vehicle Mechanic
		63H	Track Vehicle Repairer
		63S	Heavy-Wheel Vehicle Mechanic
		63T	BRADLEY Fighting Vehicle Systems Mechanic
		63W	Wheel Vehicle Mechanic
67	Aircraft Maintenance	67N	UH-1 Helicopter Repairer

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Table 3.9. continued

CMF	CMF Title	MOSs	MOS Title
71	Administration	71D	Legal Specialist
		71L	Administrative Specialist
		71M	Chaplain Assistant
		73C	Finance Specialist
		75B	Personnel Administration Specialist
		75C	Personnel Management Specialist
		75D	Personnel Records Specialist
		75E	Personnel Actions Specialist
		75Z	Personnel Sergeant
74	Record Information Operations	74B	Information Systems Operator-Analyst
		74C	Record Telecommunications Operator-Maintainer
77	Petroleum and Water	77F	Petroleum Supply Specialist
79	Recruitment and Reenlistment	00R	Recruiter/Retention NCO
88	Transportation	88M	Motor Transport Operator
		88N	Transportation Management Coordinator
91	Medical	71G	Patient Administration Specialist
		91A	Medical Equipment Repairer
		91B	Medical Specialist
		91C	Practical Nurse
		91D	Operating Room Specialist
		91E	Dental Specialist
		91K	Medical Laboratory Specialist
		91P	Radiologist Specialist
		91R	Veterinary Food Inspection Specialist
		91S	Preventive Medicine Specialist
92	Supply and Services	92A	Automated Logistical Specialist
		92Y	Unit Supply Specialist
93	Aviation Operations	93P	Aviation Operations Specialist
94	Food Services	94B	Food Service Specialist
95	Military Police	95B	Military Police
96	Military Intelligence	96B	Intelligence Analyst
98	Signals Intelligence/ Electronic Warfare Operations	98C	Signals Intelligence Analyst
		98G	Voice Interceptor

CHAPTER IV

RESULTS

A. Top 50 PMOSs

The pilot study had 7454 individuals, of whom 4014 were men and 3440 were women. After choosing the individuals in the top 50 PMOSs for each gender, the dataset for this thesis was reduced to 2768 men and 2632 women. As mentioned in the methods, the top 50 PMOSs were based on control frequency. Control frequency was used rather than case frequency or total frequency because controls should represent the general enlisted U.S. Army population. The top 50 PMOSs for control men accounted for 67.8% of the control men in the pilot study. The top 50 PMOSs for control women accounted for 77.9% of the control women in the pilot study.

B. Stratified Analysis

1. Physical Demand Rating

There was not a clear trend in the association between disabling knee injury and the increasing physical demand, although differences between categories were seen (Figures 4.1 and 4.2). The very heavy category was the referent group, and all other categories had odds of injury less than this category. There were no PMOSs represented in the top 50 for men that had a rating of light. Heavy was the lowest with an odd ratio of 0.50 (95% CI= 0.30, 0.78). Among women there was more evidence of a trend in the association between physical demand and injury. For both genders, non-whites had a

lower risk than whites for all demand categories (Figures 4.3 and 4.4). The numbers became very small for each stratum in the analysis with stratification in age.

2. Maximum Weight Lifted

There is a very clear trend for both men and women that shows increasing odds of injury as the amount of weight lifted increases (Figures 4.5 and 4.6). Among men, the heaviest category of 151-175 pounds of weight lifted had an odds ratio of 2.61 (95% CI= 1.53, 4.63). For the women, there were no PMOSs that had 126-150 pounds of maximum weight lifted which accounts for the gap in the Figure 4.6. The heaviest category of 151-175 pounds had an odds ratio of 1.89 (95% CI= 1.01, 3.52).

These trends varied by race (Figures 4.7 and 4.8). Non-white men had a clear trend of increasing odds ratios with increasing weight lifted, with an odds ratio of 4.88 (95% CI= 1.83, 16.34) for the heaviest category. There was not as strong a trend for white men, with the point estimate of 1.82 (0.95, 3.68) at the heaviest category. For women, the difference between the races was not strong except at 101-125 pounds of lifting. In this category, non-whites had a higher odds ratio than whites.

There were also age differences (Figures 4.9 and 4.10). Each age group had an increased risk of injury with increasing weight. Also, each weight category had an increased risk of injury as age increased.

3. Maximum Distance Ran/Walked

There was no trend of increased or decreased risk of injury with increasing distance ran/walked for either gender (Figure 4.11 and 4.12). The 25 mile category had

the highest odds ratio (1.86) for the men and was statistically significant. The 51-100 feet category had the highest odds ratio (1.60) for the women and was statistically significant.

The race difference for men did not follow a pattern. For women most of the categories had higher odds ratios for non-white than white, but there was still no trend for non-white women (Figures 4.13 and 4.14). In general, white women had low odds ratios for all levels of walking/running. Among men, there were generally higher odds ratios within each age group as the distance increased, with the exception of the three mile category (Figures 4.15). For women, there was no trend seen within age groups as distances increased, but within distance categories the risk of knee injury increased as age increased (Figure 4.16).

- The other maximum distance categories that were more vague in description were also analyzed (Figure 4.17 and 4.18). There were no PMOSs with a task description of long distance as the maximum distance moved for men. Only walks or runs a short distance had an odds ratio greater than 1.0 in the men. All the categories had odds ratios greater than 1.0 in the women.

There was no clear trend of race differences for either gender (Figure 4.19 and 4.20). There were differences between odds of injury for each age group for varying distances walked.

4. Maximum Time Walked

Maximum time walked showed an increased risk for the category of 2 of 6 hours and a decreased risk for the category of 4 hours duration in men (Figure 4.23). There

were no women in the 2 of 6 hours category, but the category of 4 hours duration had an increased risk compared to no walking/running (Figure 4.24). For both genders non-whites had higher odds ratios than whites (Figures 4.25 and 4.26). Among men, there were differences in odds ratios within age groups (Figure 4.27). For women, the odds ratio was found to increase with age (Figure 4.28).

5. Lift and Carry

Only odds ratios within gender were calculated for this grouping scheme because the numbers became too small with further stratification. There was a slight increase in odds ratio as the categories increased in men, but there were many fluctuations (Figure 4.29). For women, there was no obvious trend, with many fluctuations between the categories (Figure 4.30).

6. Career Management Field

There was no clear referent group for the CMF grouping scheme. For the stratified analysis, CMF 71, which was Administration, was chosen because it was present in both genders and had the high numbers of individuals for both genders. Compared to this category, most of the other CMFs in both men and women had odds ratios above unity (Table 4.1).

7. Kneeling

There were odds ratios above and below unity for the kneeling groups (Figures 4.31 - Figure 4.34). For men, kneeling to file, kneeling while shoveling 21 lbs and

kneeling while shoveling 10 pounds all had odds ratios greater than 1.0. Kneeling for 4 hours and kneeling for prolonged periods had odds ratios less than 1.0. There were no men who knelt while pushing, pulling, or lifting 50 lbs. For women, all the categories except kneeling while shoveling 21 lbs had an odds ratio less than 1.0. There were no women who knelt while shoveling 10 lbs.

8. Climbing

The climbing categories had no clear trend as the height of climbing increased (Figure 4.35 - Figure 4.38). Non-whites tended to have higher odds ratios than whites for both gender. The numbers in each strata were small when stratified by age group.

9. Sitting and Standing

The grouping schemes of sitting and standing had no clear trends, but most odds ratios were below 1.0 (Figures 4.39-4.44). The only exception was for women where standing for extended periods had an odds ratio above unity.

10. Pushing/Pulling

There were slight differences in the trends for men and women. For men, almost all the categories were below unity. The three categories which were above unity were 250 lbs, 42.5 lbs, and pushing/pulling a wrench (Figure 4.45). This was not a clear trend. In women, there was a clearer trend (Figure 4.46). The odds ratios for categories less than 130 lbs were approximately unity or below unity. The odds ratios for categories greater than or equal to 130 lbs were greater than unity. The odds ratios for the

categories of feet per pound of force were all above unity. This suggests a threshold at approximately 130 lbs.

C. Logistic Regression

The final multivariable logistic regression models for both men and women had the same variables. These were race group, age group, pushing/pulling, maximum amount lifted, kneeling, sitting, and standing (Table 4.2 and 4.3). In the male model (Table 4.2), non-white men compared to white men had a reduced risk of disabling knee injury with an adjusted odds ratio of 0.82 (95% CI= 0.68, 1.00). The age group trend followed an inverse 'U' shape, with 23-26 year olds as the referent group. The maximum lifting categories approximated a 'U' shape curve, with an adjusted odds ratio of 1.66 (95% CI= 0.47, 5.86) in the 1-25 lbs category, an adjusted odds ratio of 0.94 (95% CI= 0.46, 1.92) in the 75-100 lbs category and an adjusted odds ratio of 1.84 (95% CI= 0.91, 3.72) in the 151-175 lbs category. All types of kneeling led to increased odds of disabling knee injury compared to no kneeling. Kneeling for prolonged periods had an adjusted odds ratio of 1.53 (95% CI=0.87, 2.67), kneeling while shoveling or lifting had an adjusted odds ratio of 1.22 (95% CI= 0.88, 1.69), and kneeling while filing had an adjusted odds ratio of 2.54 (95% CI= 0.71, 9.10). Men who had jobs with sitting in a physical task description had reduced odds of disabling knee injury with an adjusted odds ratio of 0.46 (95% CI= 0.13, 1.56). Those who had standing in a physical task description also had reduced odds of disabling knee injury, with an adjusted odds ratio of 0.71 (95% CI=0.46, 1.08). Also, all pushing/pulling categories had adjusted odds ratios less than the null value.

In contrast, the multivariable logistic regression model of females included the same variables, but had different trends and adjusted odds ratios (Table 4.3). Non-white women compared to white women had a reduced risk of disabling knee injury, with an adjusted odds ratio of 0.40 (95% CI= 0.33, 0.49). This is a much lower adjusted odds ratio than the one found in the male model (OR=0.82). There were also differences in the other variables. For women, the odds of having a disabling knee injury increased with increasing age group, approximating a linear trend with 23-26 year olds as the referent group. For men, there was an inverse 'U' shape with increasing age. For maximum weight lifted, the adjusted odds ratios for women also had a 'U' shape curve as the weight increased, but the curve was shifted to the right compared to men. The adjusted odds ratio for the 1-25 lbs category was 2.31 (95% CI= 1.23, 4.34) which dropped to 0.94 (95% CI= 0.51, 1.72) in the 26-50 lbs category and then increased as weight increased. Pushing/pulling greater than 130 lbs increased the odds of having an disabling knee injury, whereas pushing/pulling less than 130 lbs of pushing/pulling in feet per pound of force did not increase the odds of injury. Having sitting as a physical task description decreased the odds of injury, with an adjusted odds ratio of 0.51 (95% CI= 0.28, 0.94). Standing in a physical task description also reduced the risk of a disabling knee injury, with an adjusted odds ratio of 0.83 (95% CI= 0.61, 1.14).

Both of these models had a very good fit using the Hosmer-Lemeshow Goodness of Fit Test. This test calculated a p-value of 0.9130 for the male model and a p-value of 0.9690 for the female model.

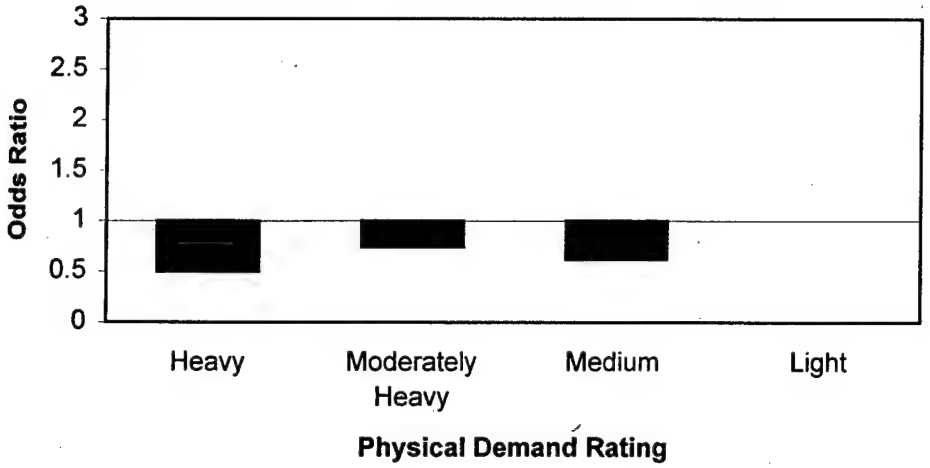

Figure 4.1. Relative odds of disabling knee injury with physical demand rating compared to the very heavy rating for men in the U.S. Army, 1980-1994

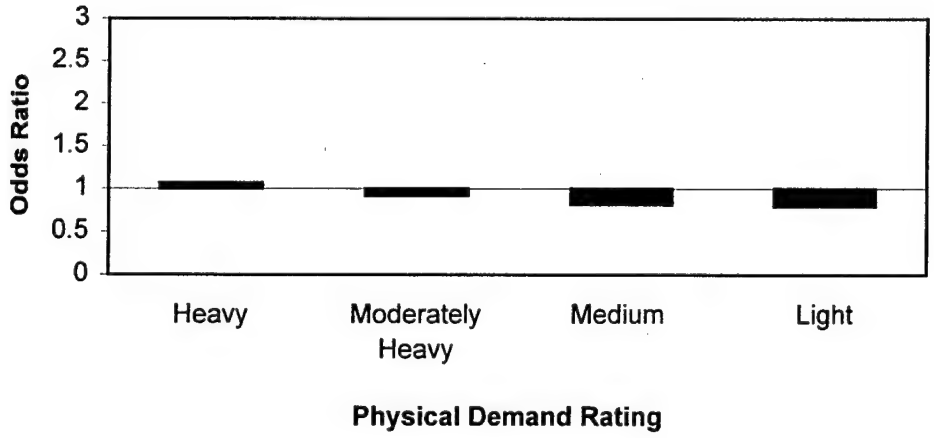

Figure 4.2. Relative odds of disabling knee injury with physical demand rating compared to the very heavy rating for women in the U.S. Army, 1980-1994

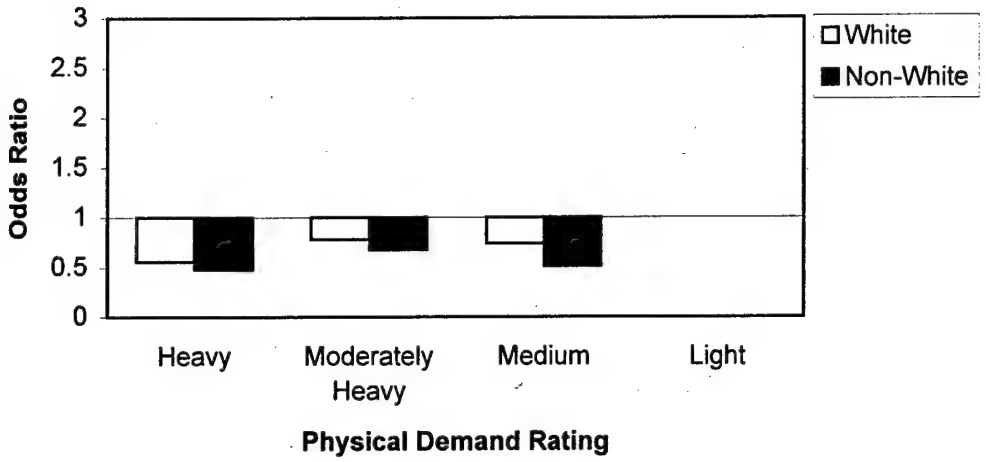

Figure 4.3. Relative odds of disabling knee injury with physical demand ratings compared to the very heavy rating for men in the U.S. Army, 1980-1994 - stratified by race

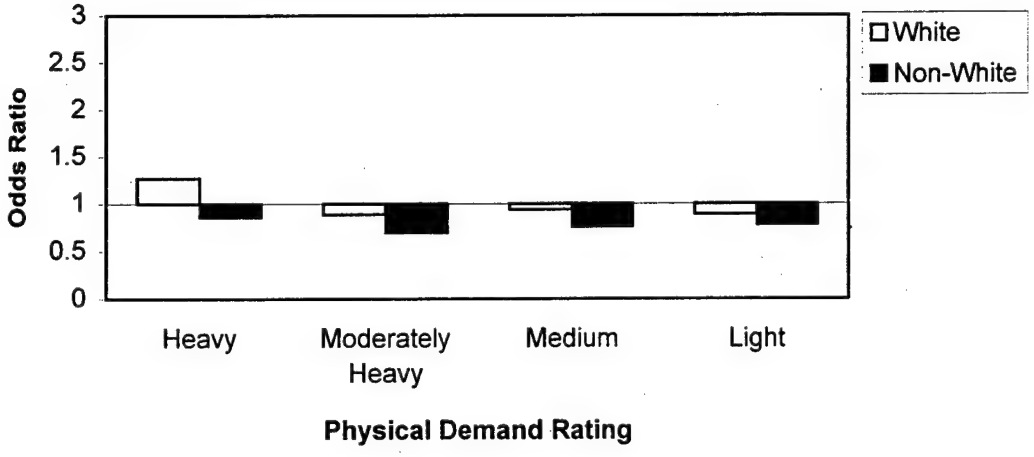

Figure 4.4. Relative odds of disabling knee injury with physical demand ratings compared to the very heavy rating for women in the U.S. Army, 1980-1994 - stratified by race

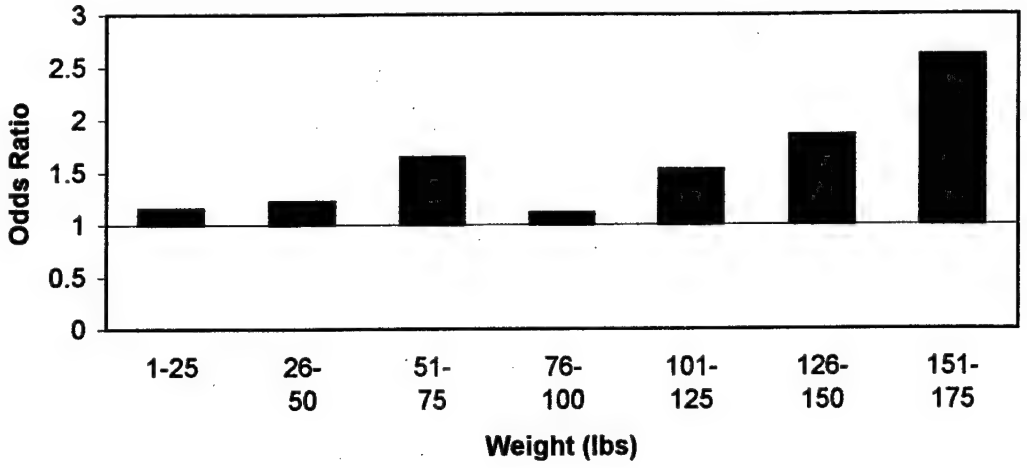

Figure 4.5. Relative odds of disabling knee injury with maximum weight ~~lifted~~ compared to no weight lifted for men in the U.S. Army, 1980-1994

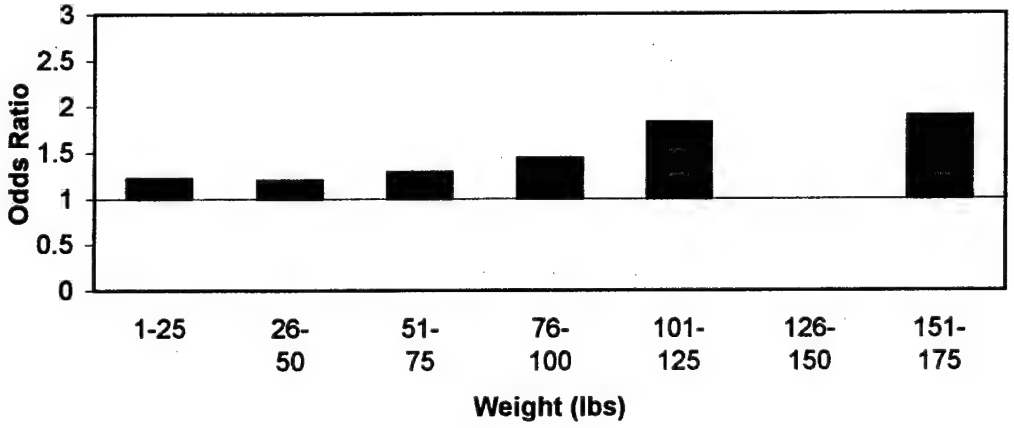

Figure 4.6. Relative odds of disabling knee injury with maximum weight lifted compared to no weight lifted for women in the U.S. Army, 1980-1994

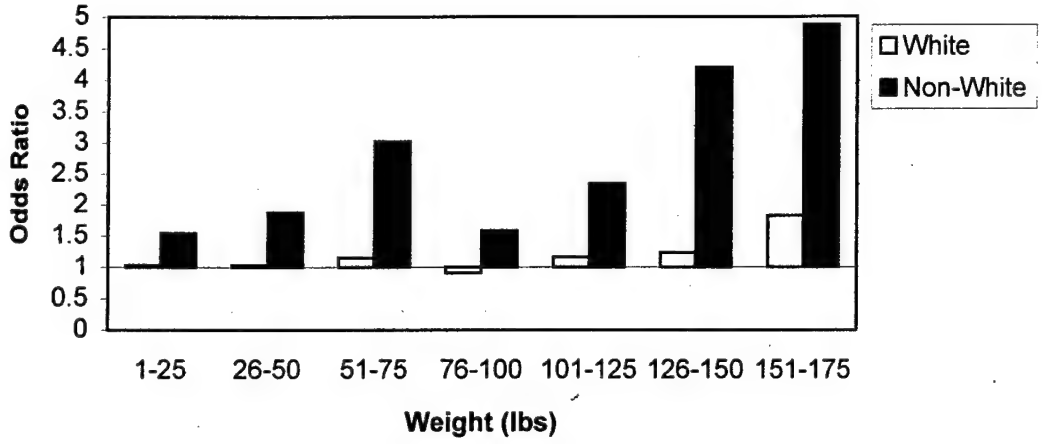

Figure 4.7. Relative odds of disabling knee injury with maximum weight lifted compared to no weight lifted for men in the U.S. Army, 1980-1994 - stratified by race

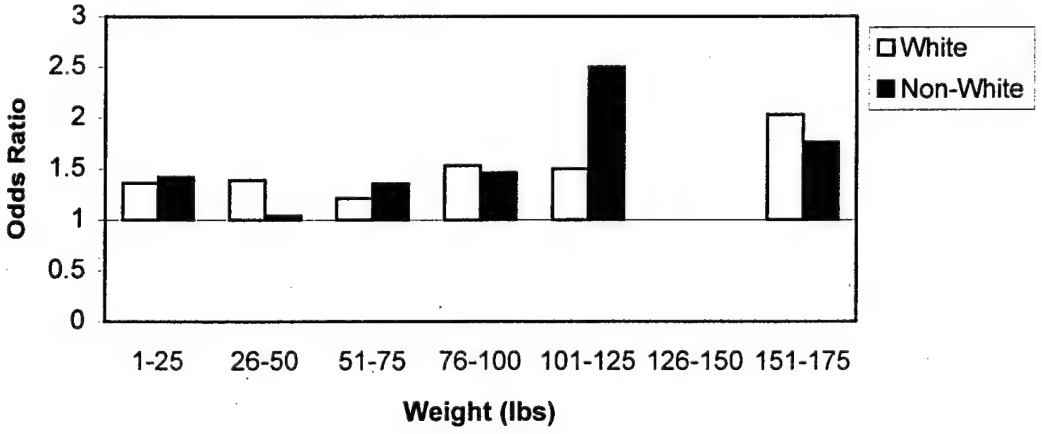

Figure 4.8. Relative odds of disabling knee injury with maximum weight lifted compared to no weight lifted for women in the U.S. Army, 1980-1994 - stratified by race

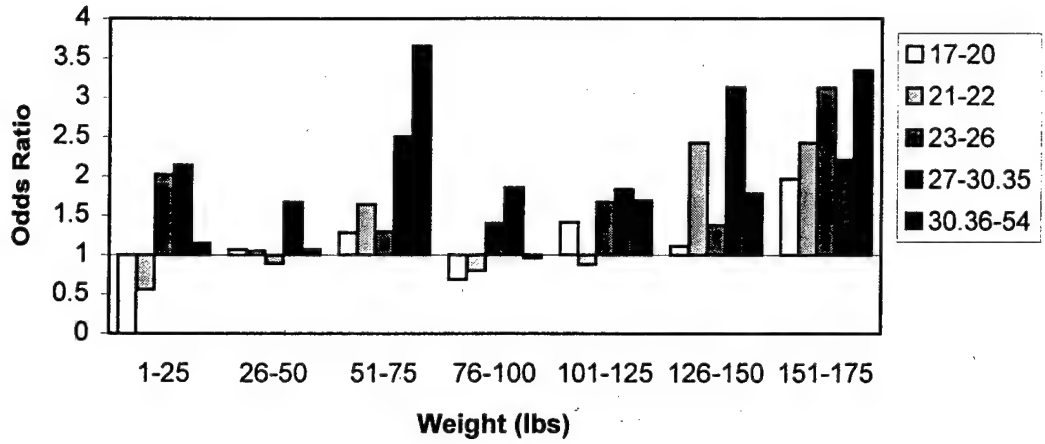

Figure 4.9. Relative odds of disabling knee injury with maximum weight lifted compared to no weight lifted for men in the U.S. Army, 1980-1994 - stratified by age in years

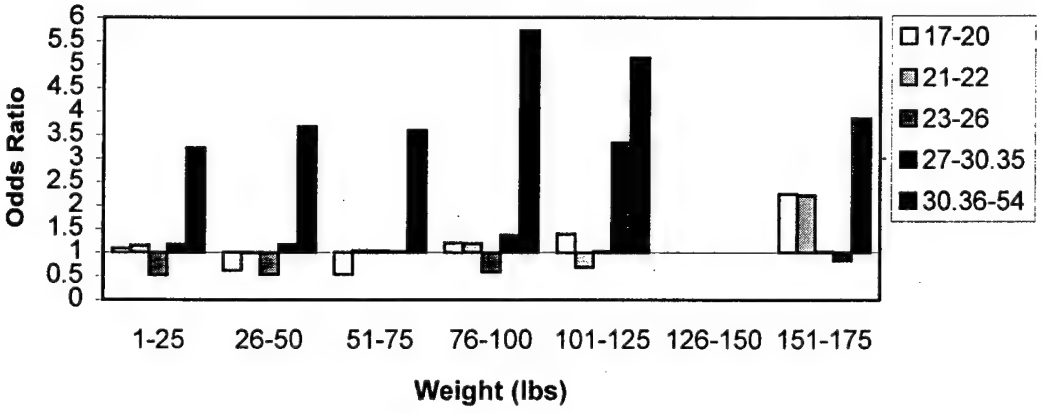

Figure 4.10. Relative odds of disabling knee injury with maximum weight lifted compared to no weight lifted for women in the U.S. Army, 1980-1994 - stratified by age in years

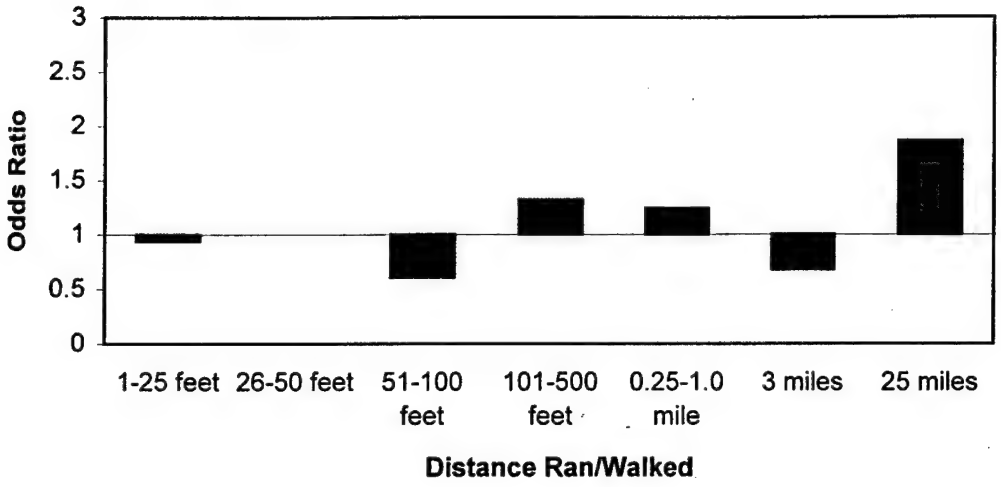

Figure 4.11. Relative odds of disabling knee injury with maximum distance ran/walked compared to no running/walking for men in the U.S. Army, 1980-1994

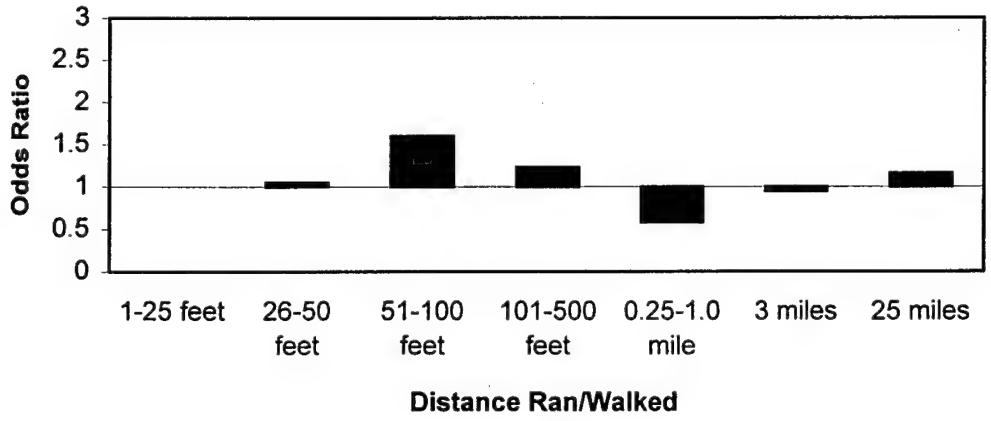

Figure 4.12. Relative odds of disabling knee injury with maximum distance ran/walked compared to no running/walking for women in the U.S. Army, 1980-1994

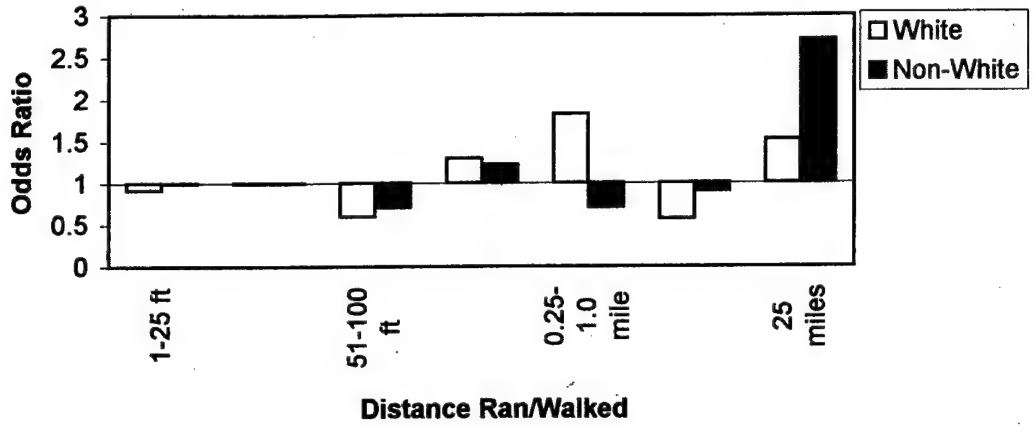

Figure 4.13. Relative odds of disabling knee injury with maximum distance ran/walked compared to no running/walking for men in the U.S. Army, 1980-1994 - stratified by race

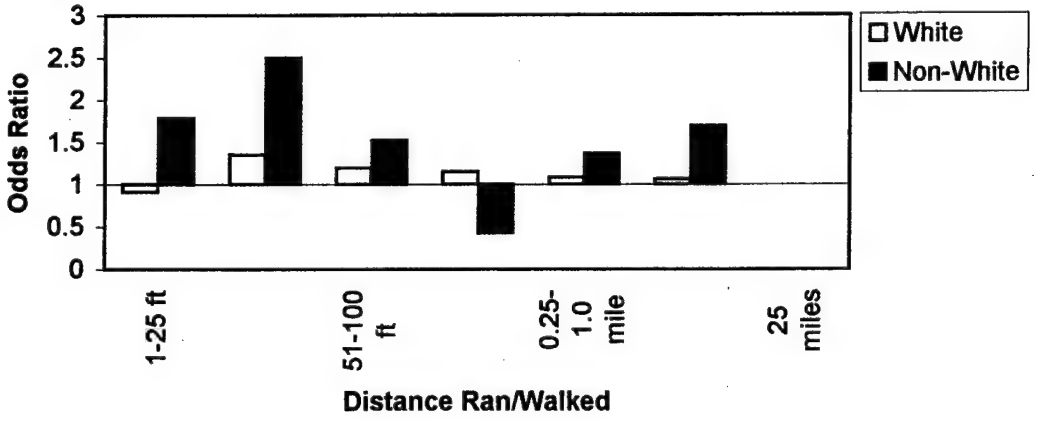

Figure 4.14. Relative odds of disabling knee injury with maximum distance ran/walked compared to no running/walking for women in the U.S. Army, 1980-1994 - stratified by race

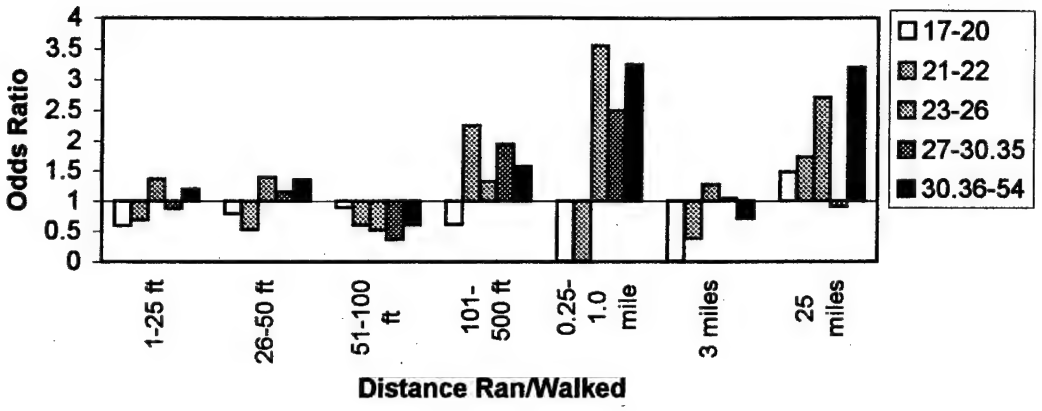

Figure 4.15. Relative odds of disabling knee injury with maximum distance ran/walked compared to no running/walking for men in the U.S. Army, 1980-1994 - stratified by age in years

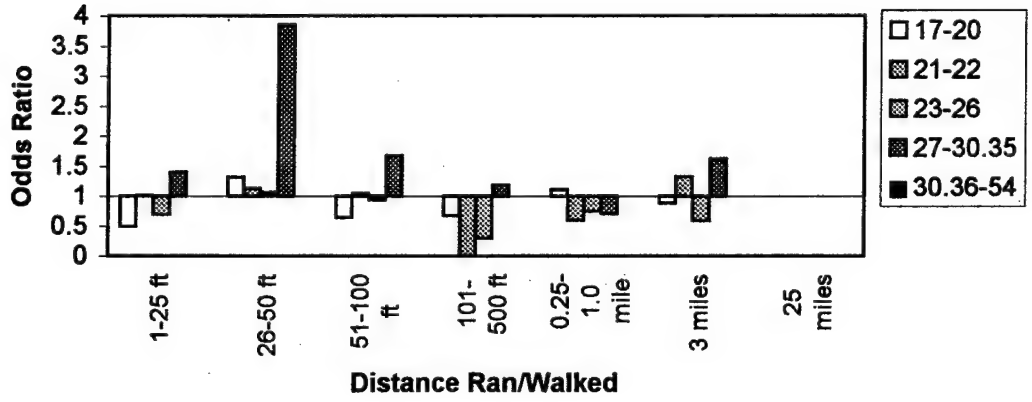

Figure 4.16. Relative odds of disabling knee injury with maximum distance ran/walked compared to no running/walking for women in the U.S. Army, 1980-1994 -stratified by age in years

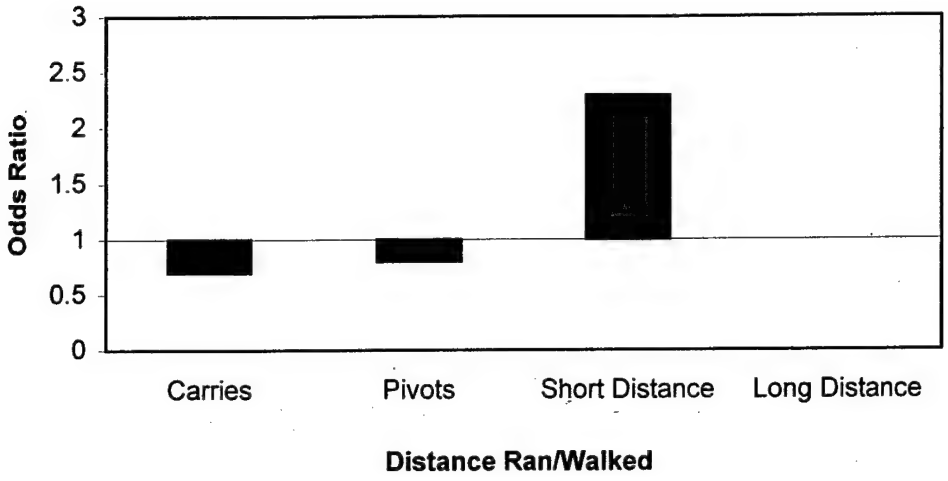

Figure 4.17. Relative odds of disabling knee injury with other maximum distance ran/walked groups compared to no running/walking for men in the U.S. Army, 1980-1994

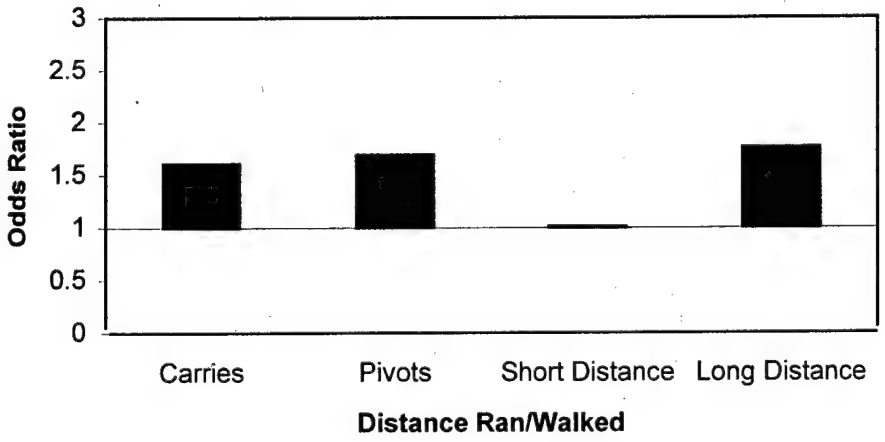

Figure 4.18. Relative odds of disabling knee injury with other maximum distance ran/walked groups compared to no running/walking for women in the U.S. Army, 1980-1994

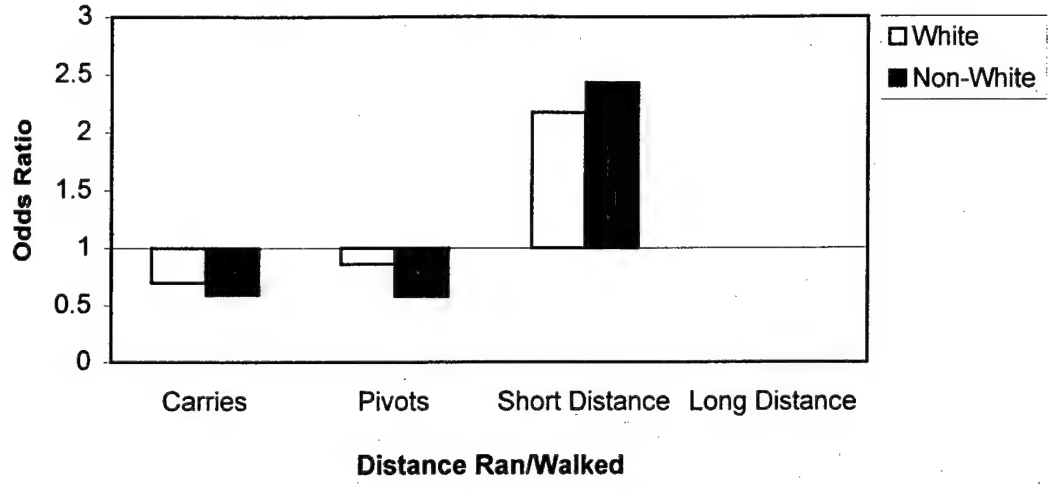

Figure 4.19. Relative odds of disabling knee injury with other maximum distance ran/walked groups compared to no running/walking for men in the U.S. Army, 1980-1994 - stratified by race

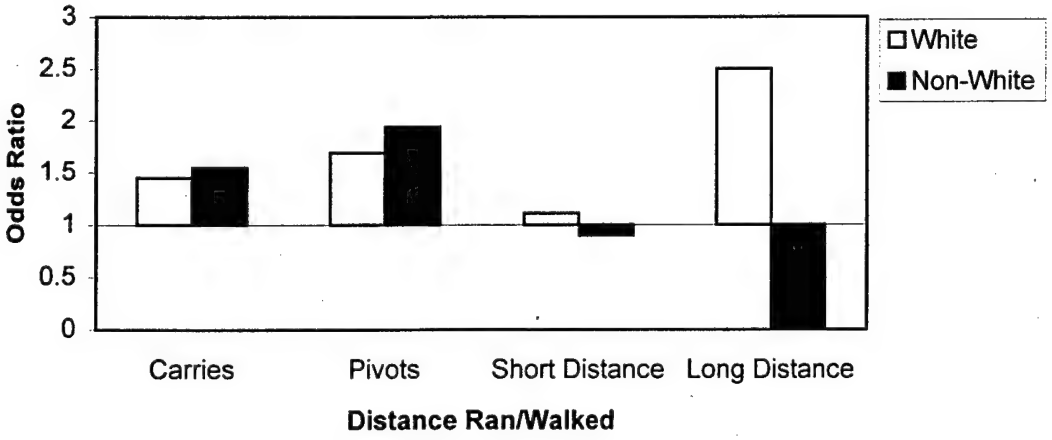

Figure 4.20. Relative odds of disabling knee injury with other maximum distance ran/walked groups compared to no running/walking for women in the U.S. Army, 1980-1994 - stratified by race

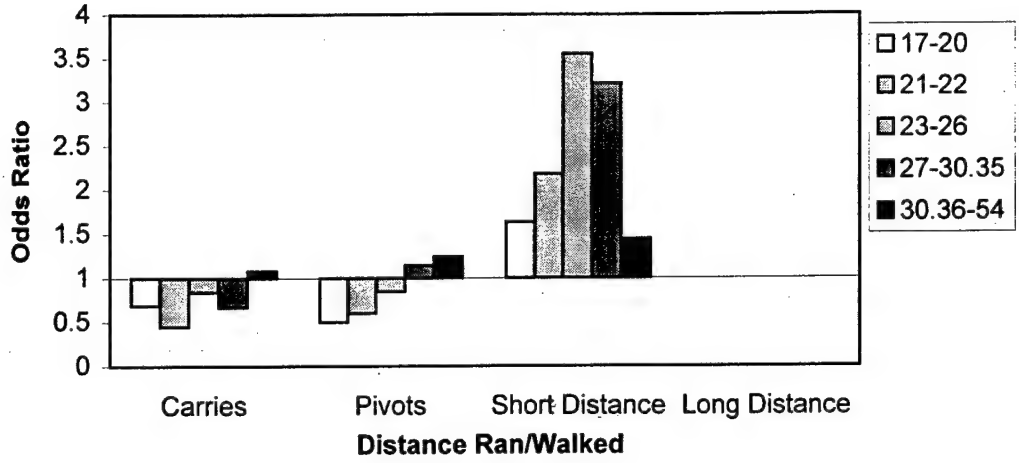

Figure 4.21. Relative odds of disabling knee injury with other maximum distance walked groups compared to no running/walking for men in the U.S. Army, 1980-1994 - stratified by age in years

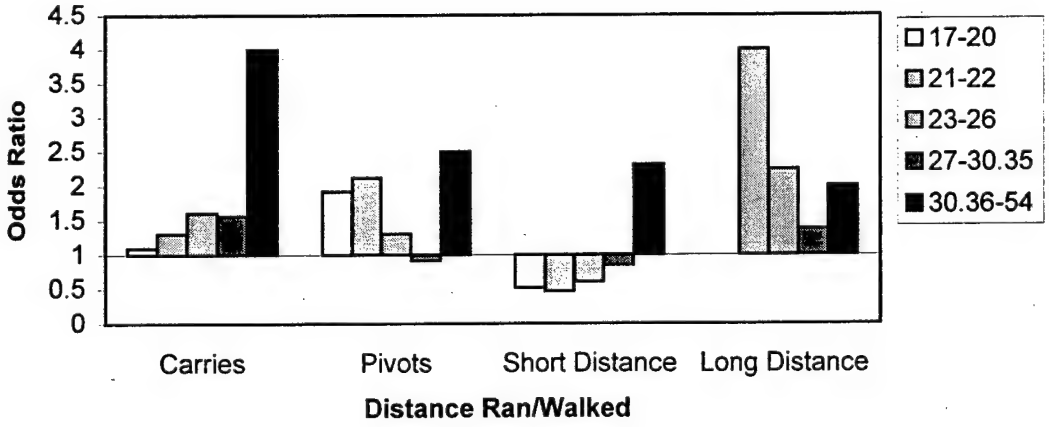

Figure 4.22. Relative odds of disabling knee injury with other maximum distance ran/walked groups compared to no running/walking for women in the U.S. Army, 1980-1994 - stratified by age in years

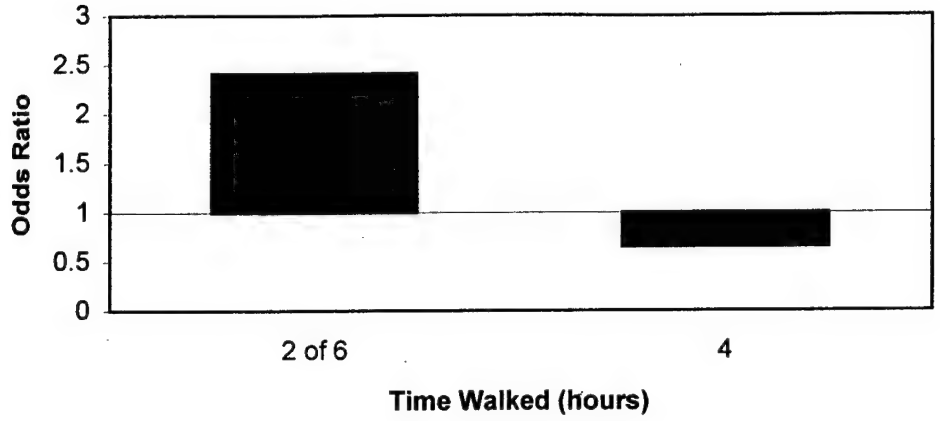

Figure 4.23. Relative odds of disabling knee injury with maximum time walked compared to no time walked for men in the U.S. Army, 1980-1994

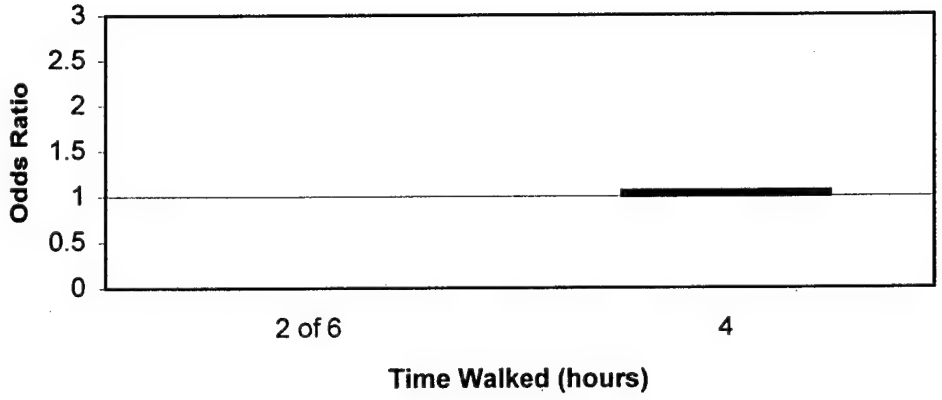

Figure 4.24. Relative odds of disabling knee injury with maximum time walked compared to no time walked for women in the U.S. Army, 1980-1994

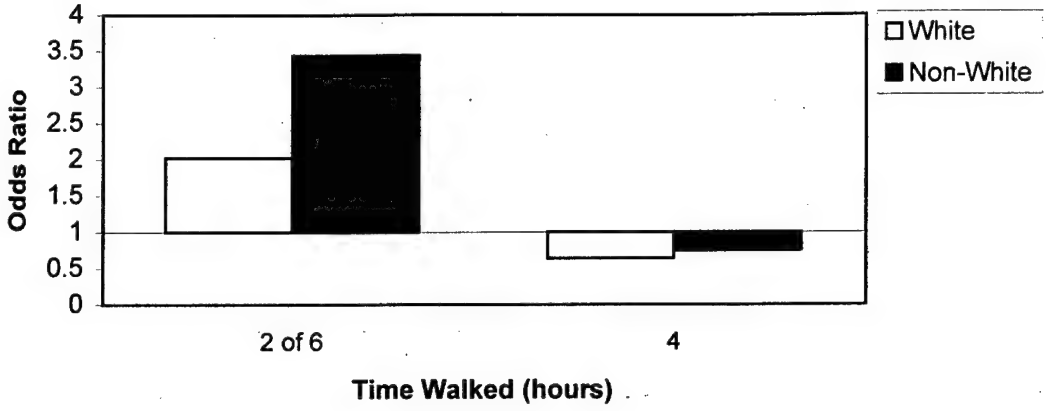

Figure 4.25. Relative odds of disabling knee injury with maximum time walked compared to no time walked for men in the U.S. Army, 1980-1994 - stratified by race

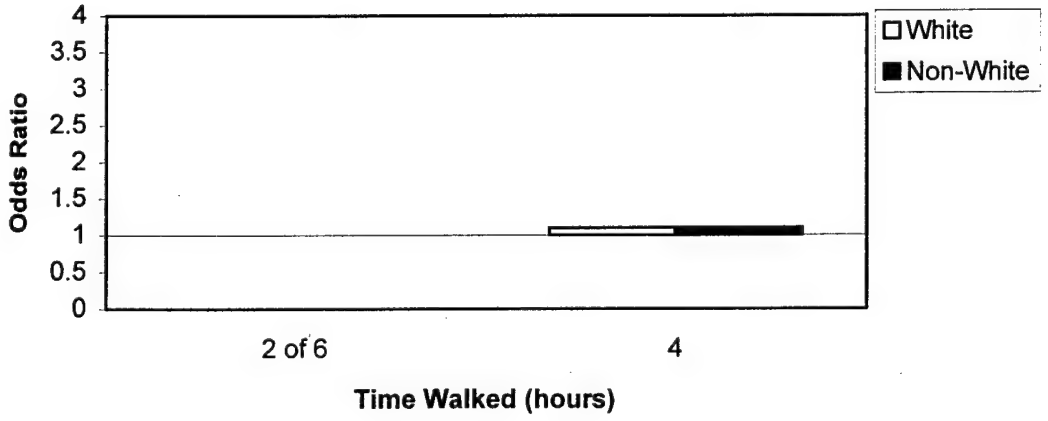

Figure 4.26. Relative odds of disabling knee injury with maximum time walked compared to no time walked for women in the U.S. Army, 1980-1994 - stratified by race

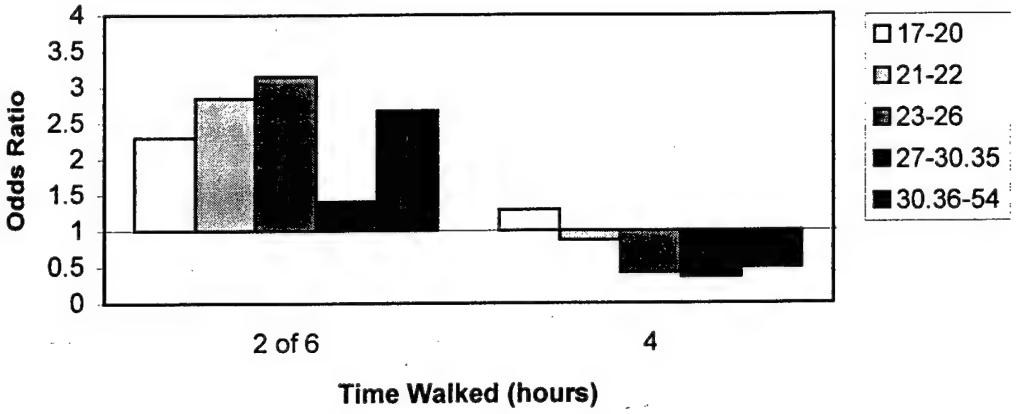

Figure 4.27. Relative odds of disabling knee injury with maximum time walked compared to no time walked for men in the U.S. Army, 1980-1994 - stratified by age in years

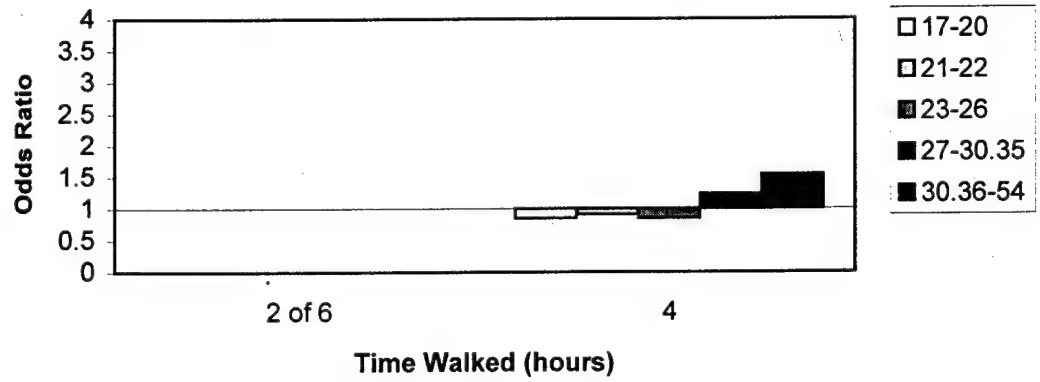

Figure 4.28. Relative odds of disabling knee injury with maximum time walked compared to no time walked for women in the U.S. Army, 1980-1994 -stratified by age in years

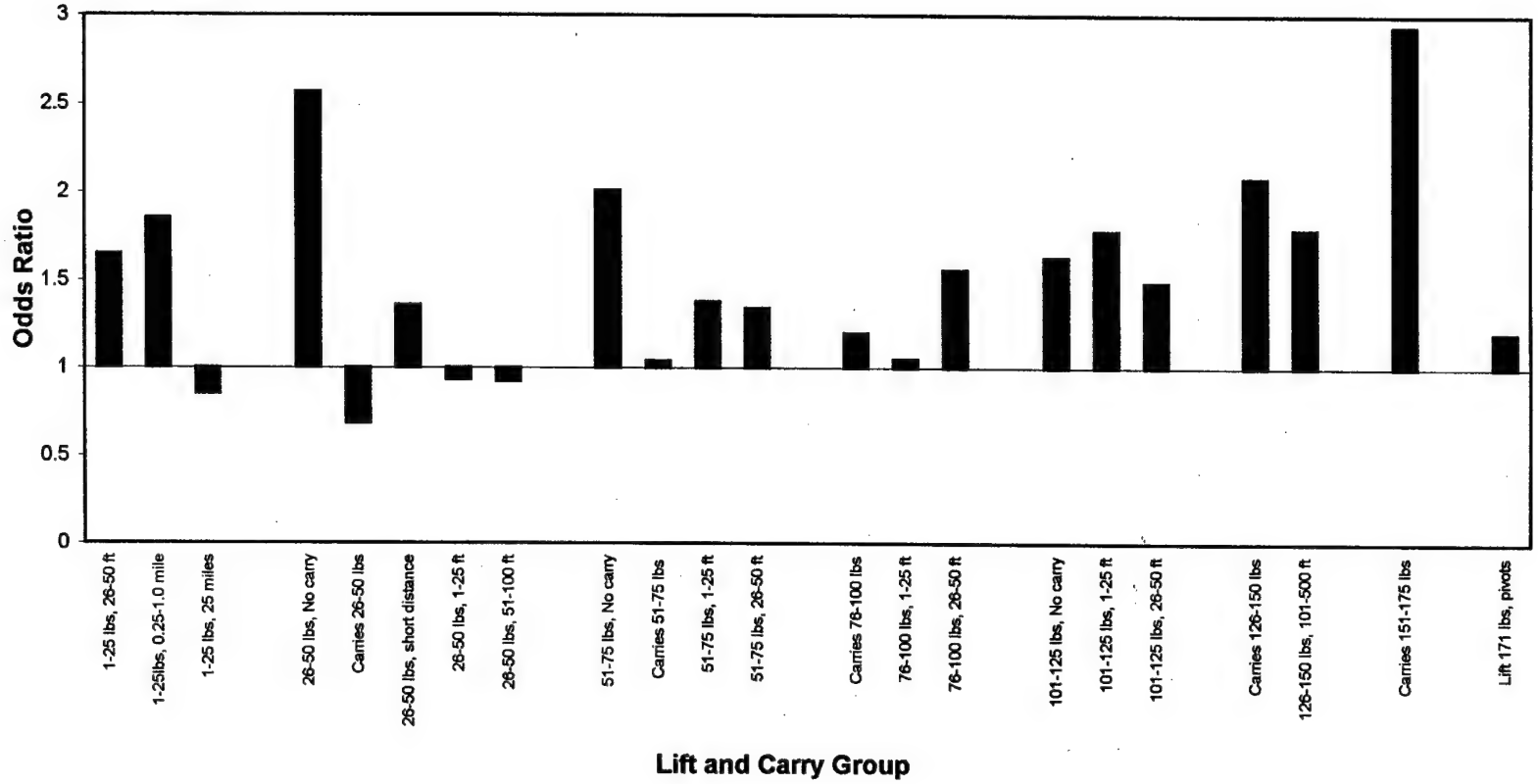

Figure 4.29. Relative odds of disabling knee injury with lift and carry groups compared to no lifting/no carrying for men in the U.S. Army, 1980-1994

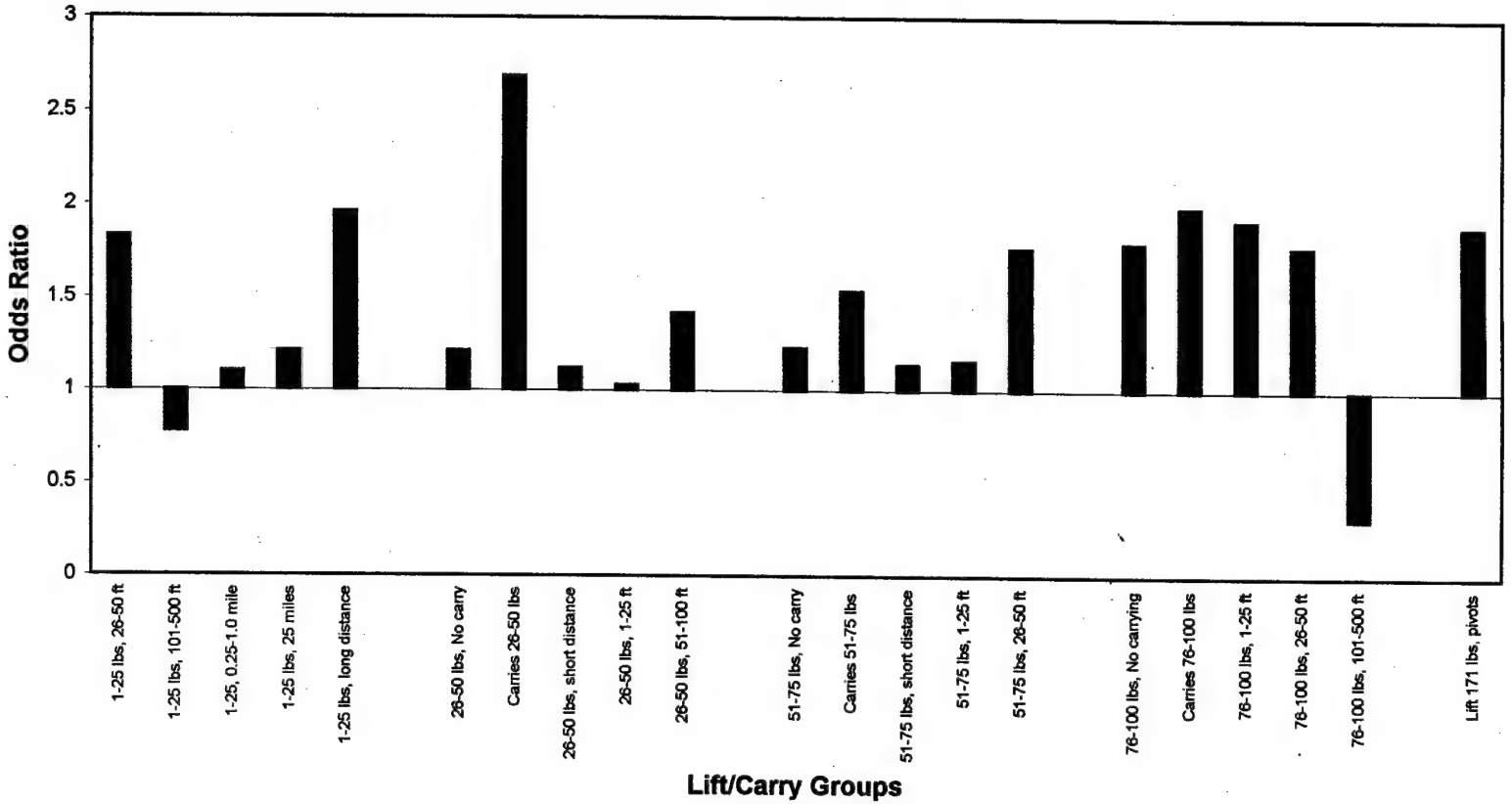

Figure 4.30. Relative odds of disabling knee injury with lift and carry groups compared to no lift/no carry for women in the U.S. Army, 1980-1994

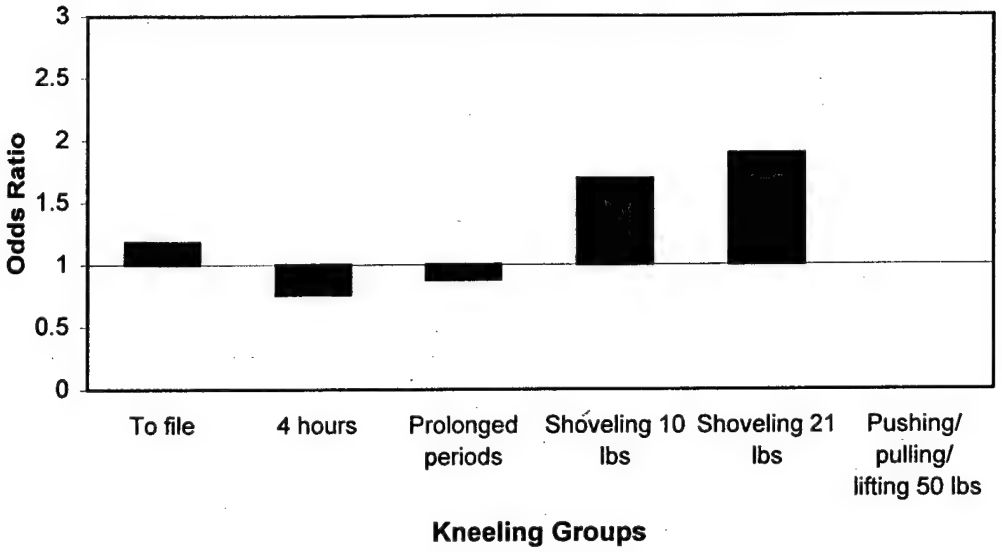

Figure 4.31. Relative odds of disabling knee injury with kneeling groups compared to no kneeling for men in the U.S. Army, 1980-1994

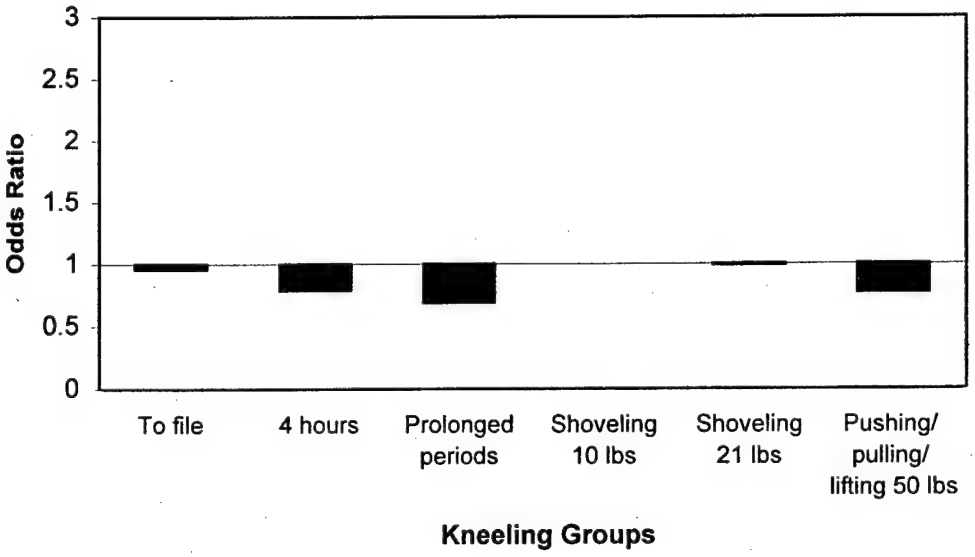

Figure 4.32. Relative odds of disabling knee injury with kneeling groups compared to no kneeling for women in the U.S. Army, 1980-1994

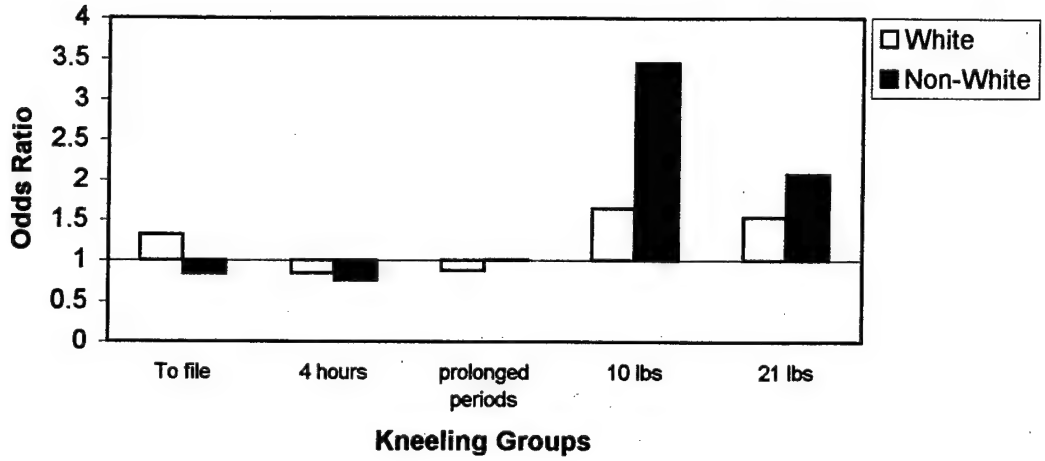

Figure 4.33. Relative odds of disabling knee injury kneeling groups compared to no kneeling for men in the U.S. Army, 1980-1994 - stratified by race

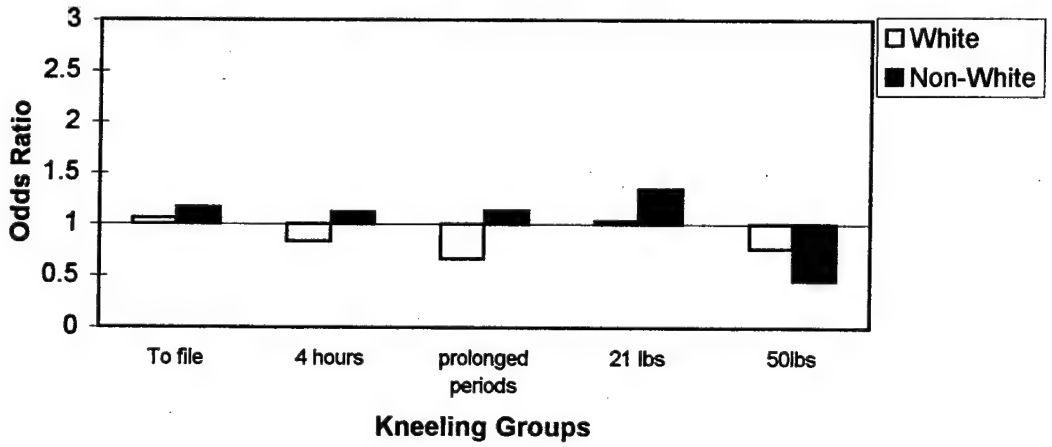

Figure 4.34. Relative odds of disabling knee injury with kneeling groups compared to no kneeling for women in the U.S. Army, 1980-1994 - stratified by race

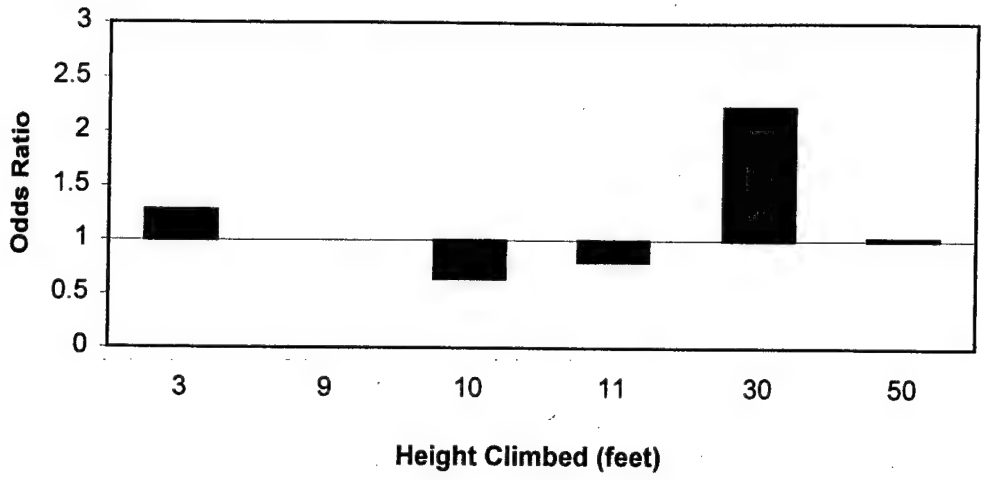

Figure 4.35. Relative odds of disabling knee injury with climbing groups compared to no climbing for men in the U.S. Army, 1980-1994

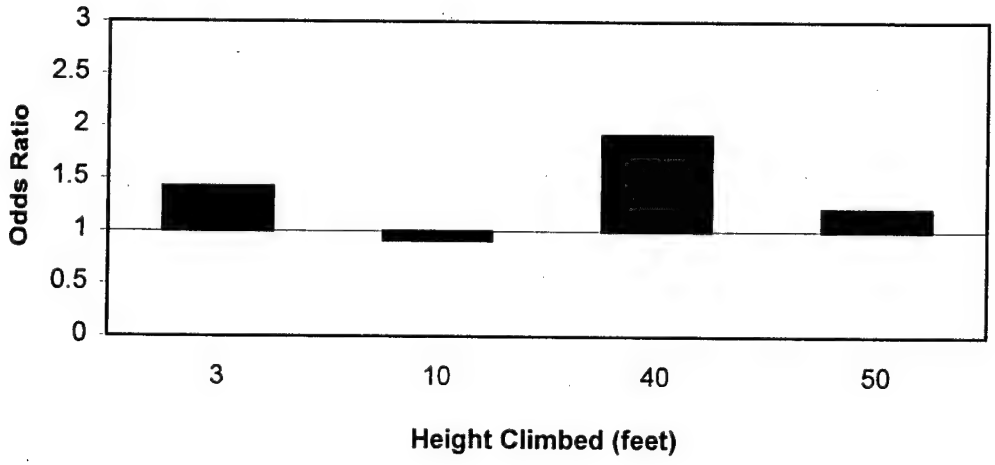

Figure 4.36. Relative odds of disabling knee injury with climbing groups compared to no climbing for women in the U.S. Army, 1980-1994

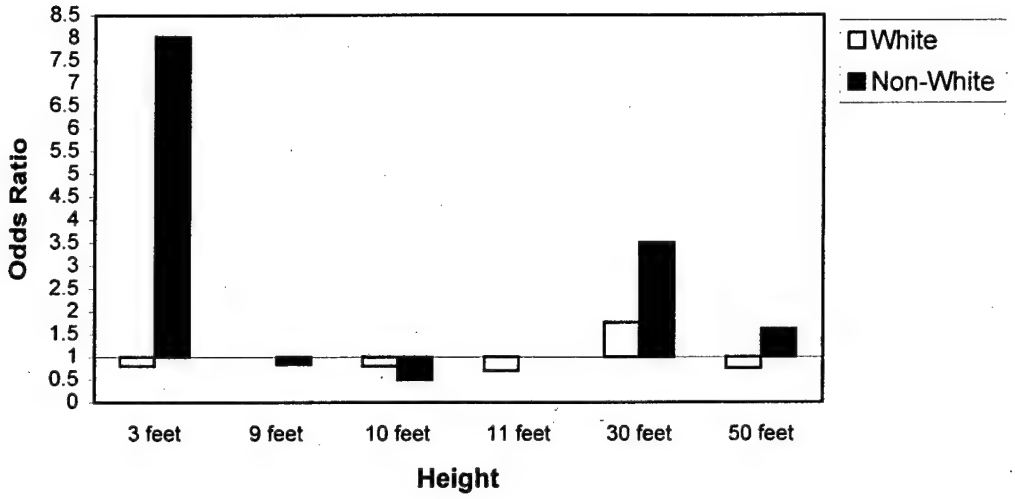

Figure 3.37. Relative odds of disabling knee injury with climbing groups compared to no climbing for men in the U.S. Army, 1980-1994 - stratified by race

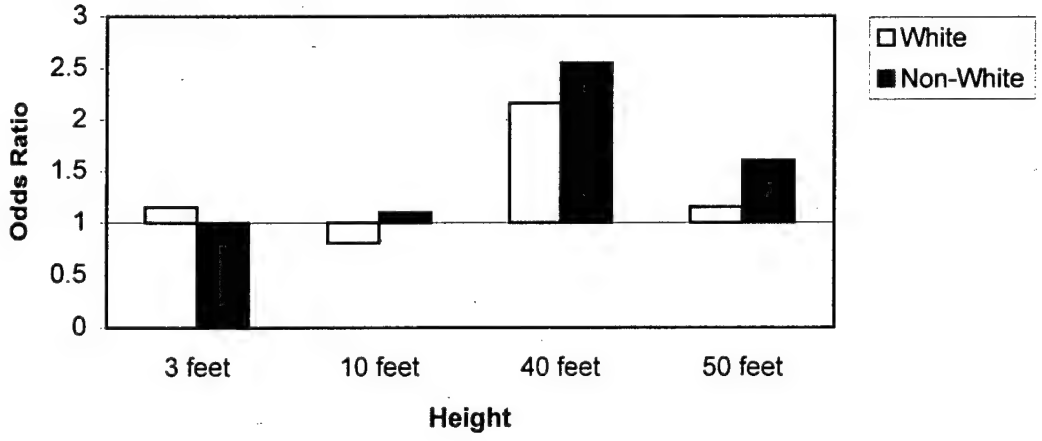

Figure 3.38. Relative odds of disabling knee injury with climbing groups compared to no climbing for women in the U.S. Army, 1980-1994 - stratifed by race

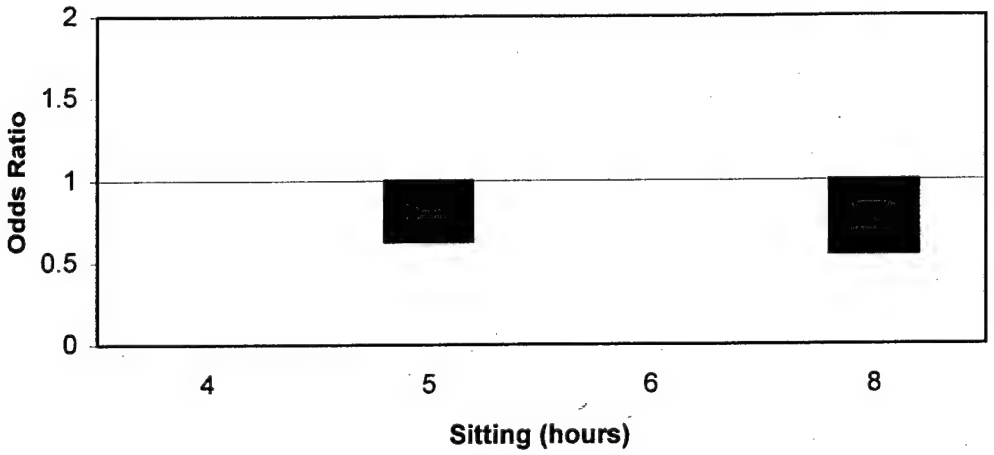

Figure 4.39. Relative odds of disabling knee injury with sitting groups compared to no sitting for men in the U.S. Army, 1980-1994

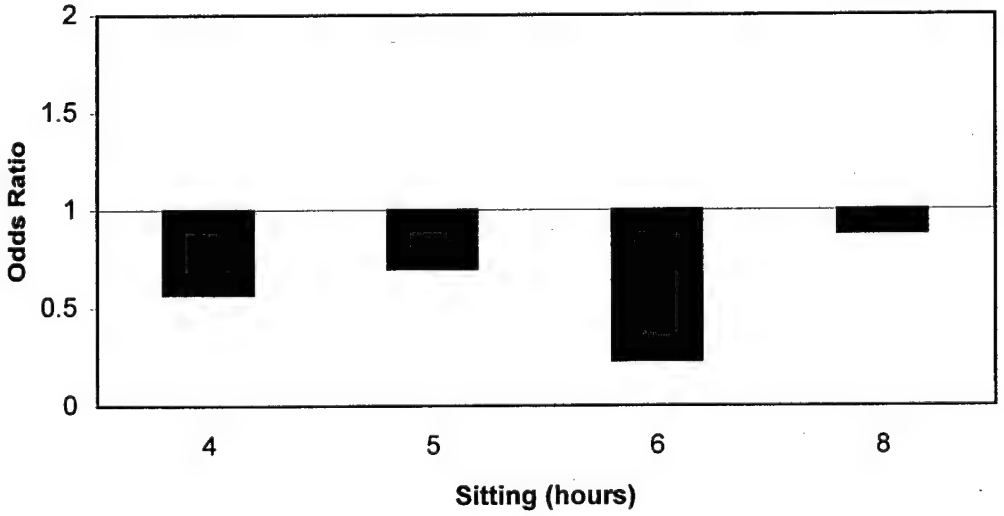

Figure 4.40. Relative odds of disabling knee injury with sitting groups compared to no sitting for women in the U.S. Army, 1980-1994

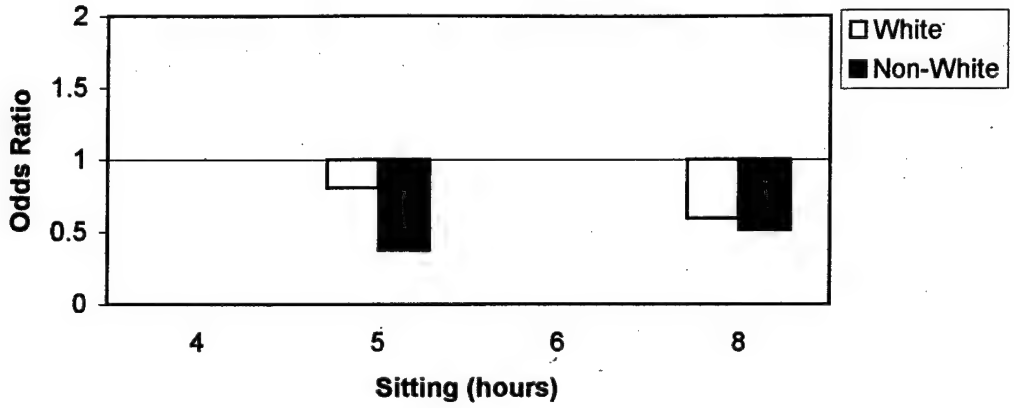

Figure 4.41. Relative odds of disabling knee injury with sitting groups compared to no sitting for men in the U.S. Army, 1980-1994 - stratified by race

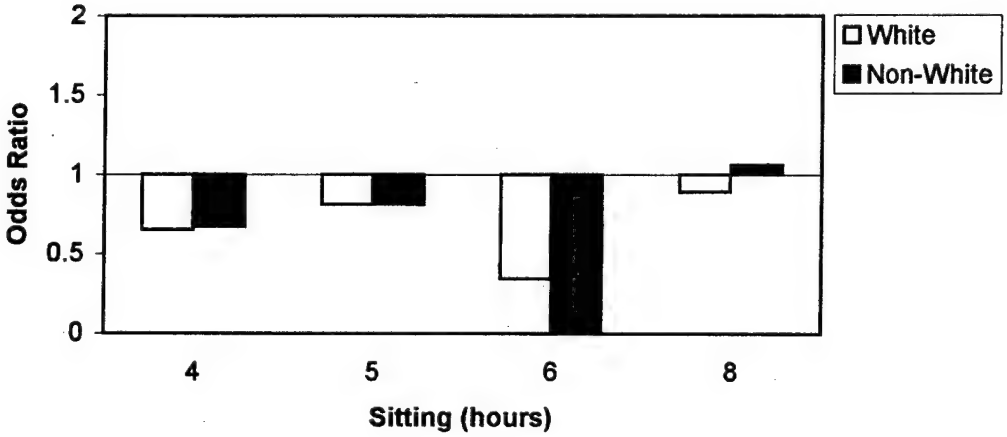

Figure 4.42. Relative odds of disabling knee injury with sitting groups compared to no sitting for women in the U.S. Army, 1980-1994 - stratified by race

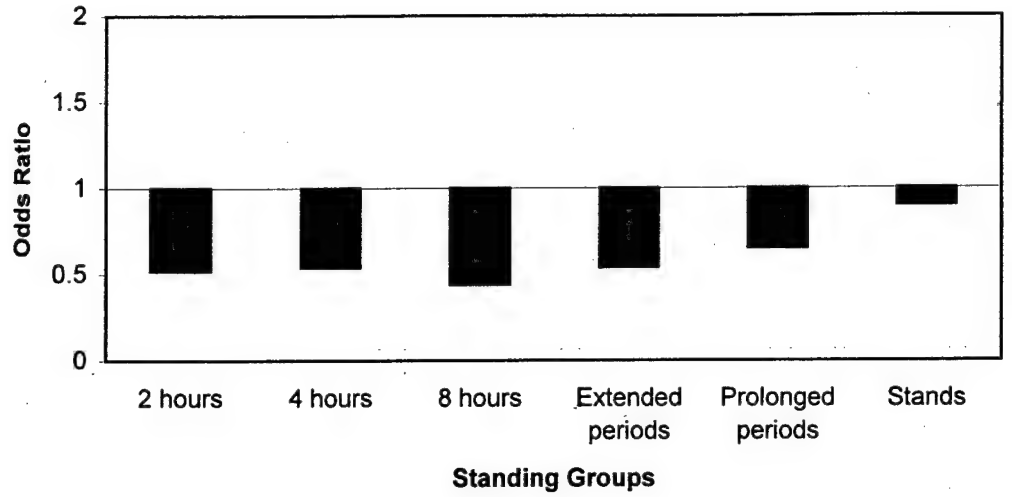

Figure 4.43. Relative odds of disabling knee injury with standing groups compared to no standing for men in the U.S. Army, 1980-1994

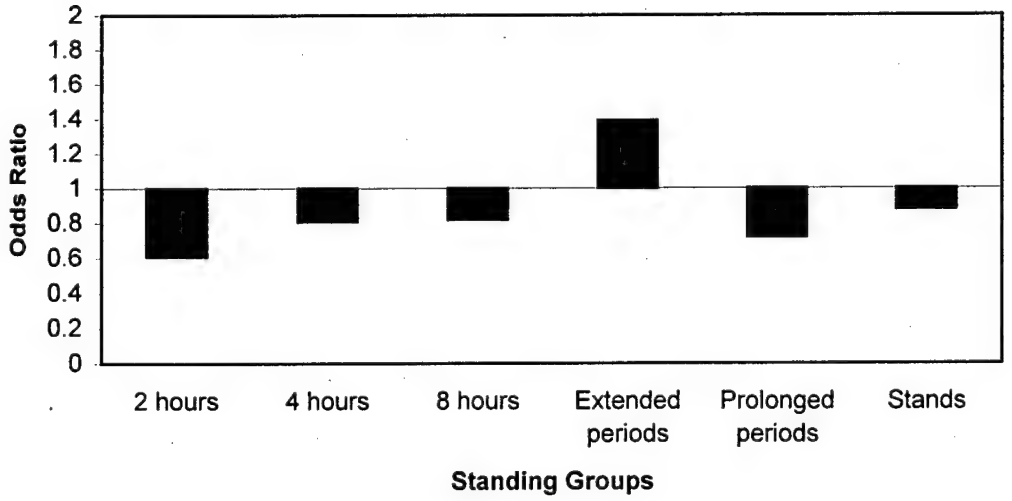

Figure 4.44. Relative odds of disabling knee injury with standing groups compared to no standing for women in the U.S. Army, 1980-1994

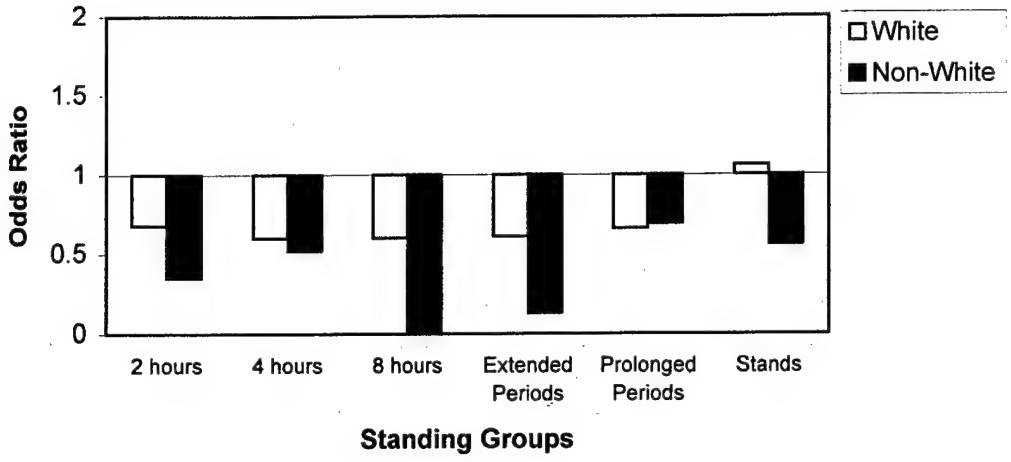

Figure 4.45. Relative odds of disabling knee injury with standing groups compared to no standing for men in the U.S. Army, 1980-1994 - stratified by race

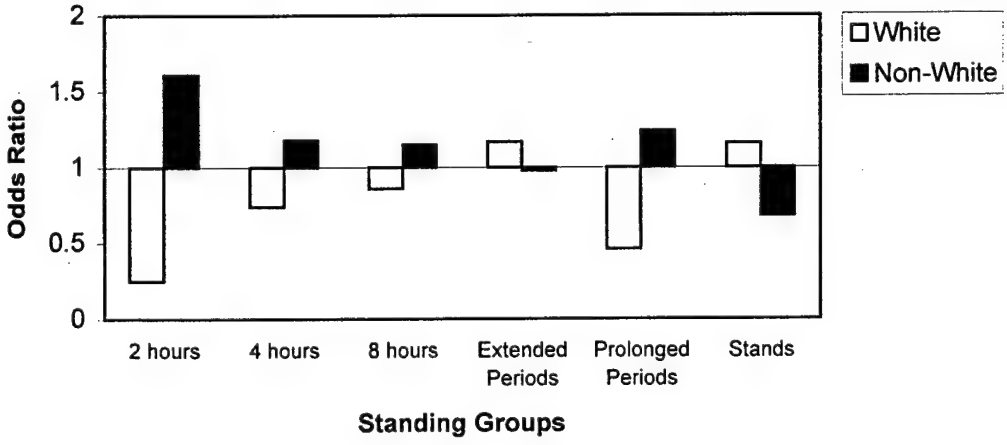

Figure 4.46. Relative odds of disabling knee injury with standing groups compared to no standing for women in the U.S. Army, 1980-1994 - stratified by race

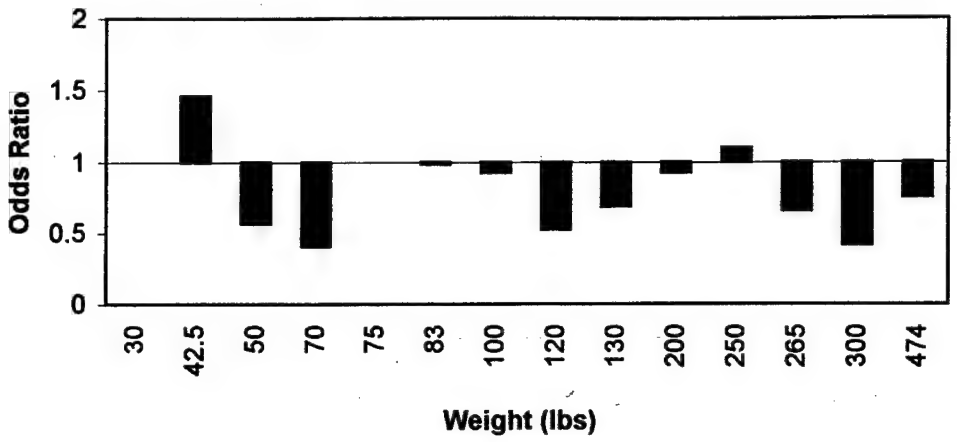

Figure 4.47. Relative odds of disabling knee injury with pushing/pulling groups compared to no pushing/pulling for men in the U.S. Army, 1980-1994

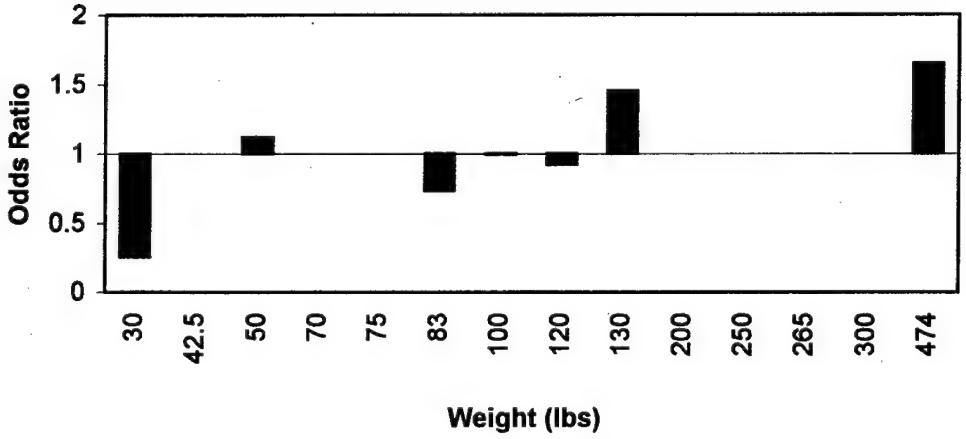

Figure 4.48. Relative odds of disabling knee injury with pushing/pulling groups compared to no pushing/pulling for women in the U.S. Army, 1980-1994

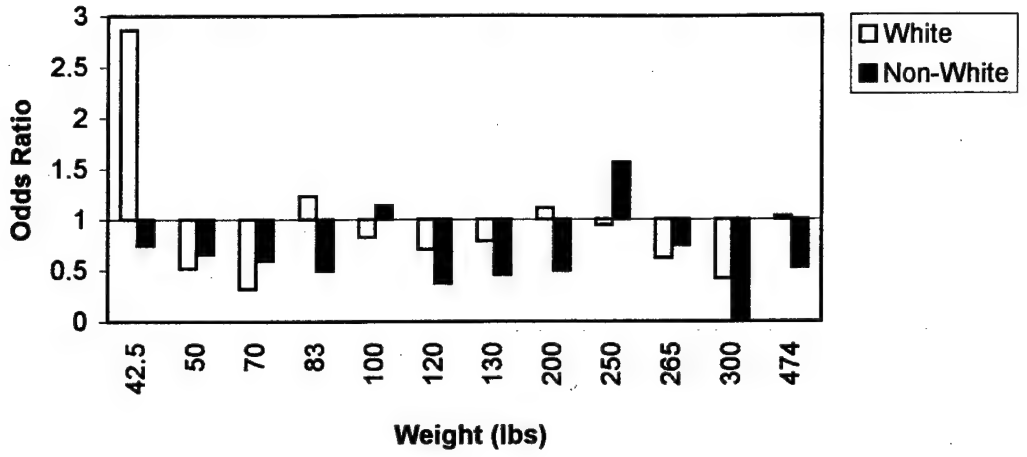

Figure 4.49. Relative odds of disabling knee injury with pushing/pulling groups compared to no pushing/pulling for men in the U.S. Army, 1980-1994 - stratified by race

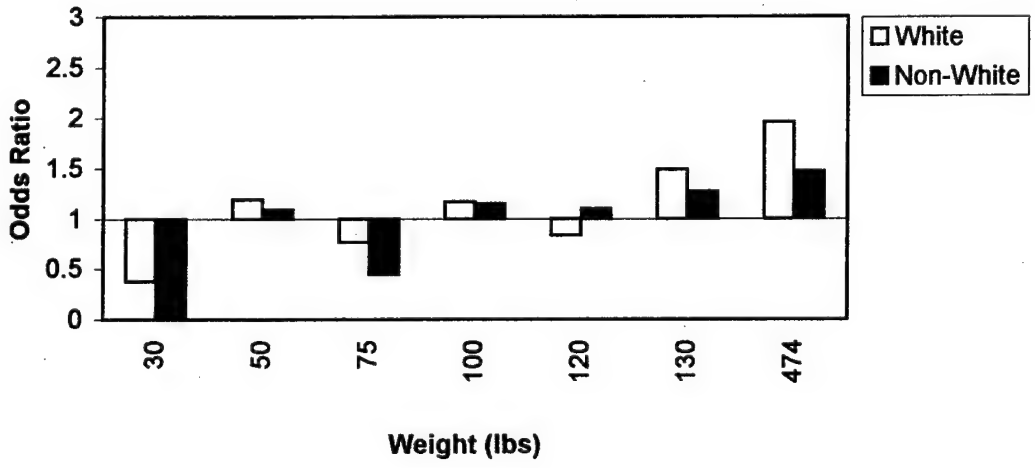

Figure 4.50. Relative odds of disabling knee injury with pushing/pulling groups compared to no pushing/pulling for women in the U.S. Army, 1980-1994 - stratified by race

Table 4.1. Career Management Field Groups (CMF) Compared to CMF 71

		MEN		WOMEN	
CMF	CMF Title	OR*	95% CI†	OR*	95% CI†
11	Infantry	3.24	(1.93, 5.66)		
12	Combat Engineer	2.10	(1.09, 4.10)		
13	Field Artillery	1.87	(1.05, 3.44)		
14	Air Defense Artillery	1.49	(0.68, 3.08)		
19	Armor	1.60	(0.87, 2.99)		
31	Signals Operator	1.65	(0.87, 3.16)	1.72	(1.14, 2.56)
51	General Engineer	2.29	(0.80, 6.22)		
54	Chemical	1.46	(0.59, 3.46)	1.93	(0.86, 4.12)
55	Ammunition	1.02	(0.17, 4.11)	1.07	(0.31, 3.06)
63	Mechanical Maintenance	1.12	(0.80, 1.57)	1.74	(1.10, 2.72)
67	Aircraft Maintenance	1.27	(0.28, 4.54)		
71	Administration	1.00‡		1.00‡	
74	Record Information Operations	1.02	(0.17, 4.11)	1.14	(0.70, 1.80)
77	Petroleum and Water	1.63	(0.55, 4.43)	1.43	(0.74, 2.63)
79	Recruitment and Reenlistment	0.90	(0.15, 3.56)		
88	Transportation	1.32	(0.65, 2.69)	1.51	(0.96, 2.35)
91	Medical	1.40	(0.72, 2.76)	1.09	(0.82, 1.46)
92	Supply and Services	1.35	(0.71, 2.61)	0.89	(0.63, 1.23)
93	Aviation Operations			0.30	(0.01, 2.01)
94	Food Services	1.01	(0.46, 2.17)	1.28	(0.81, 1.97)
95	Military Police	1.10	(0.54, 2.24)	1.84	(1.20, 2.81)
96	Military Intelligence	1.82	(0.46, 6.14)	1.68	(0.70, 3.76)
98	Signals Intelligence/ Electronic Warfare Operations	2.04	(0.57, 6.42)	1.81	(1.10, 2.94)

* Odds ratio

† 95% Confidence interval

‡ Referent group

Table 4.2. Logistic regression model for males who have PMOSs in the top 50

Variable	Group	n	OR*	95% CI†
Race	White	1764	1.00‡	
	Non-white	1004	0.82	(0.68, 1.00)
Age	17-20 years old	519	0.59	(0.45, 0.77)
	21-22 years old	535	0.65	(0.50, 0.85)
	23-26 years old	731	1.00‡	
	27-30.35 years old	371	0.99	(0.75, 1.31)
	30.36-54 years old	532	0.86	(0.66, 1.12)
Maximum Lifting	None	107	1.00‡	
	1-25 lbs	121	1.66	(0.47, 5.86)
	26-50 lbs	153	1.13	(0.45, 2.86)
	51-75 lbs	249	1.36	(0.68, 2.71)
	76-100 lbs	500	0.94	(0.46, 1.92)
	101-125 lbs	725	1.26	(0.66, 2.41)
	126-150 lbs	98	1.38	(0.61, 3.13)
	151-175 lbs	761	1.84	(0.91, 3.72)
	Raises 267 lbs	54	1.42	(0.55, 3.68)
Pushing/Pulling	None	2052	1.00‡	
	<130 lbs	262	0.86	(0.53, 1.40)
	≥ 130 lbs	387	0.75	(0.53, 1.05)
	ft/lb force	38	0.60	(0.22, 1.65)
	A wrench	29	0.99	(0.36, 2.75)
Kneeling	None	1575	1.00‡	
	Prolonged periods	274	1.53	(0.87, 2.67)
	While shoveling or lifting	900	1.22	(0.88, 1.69)
	While filing	19	2.54	(0.71, 9.10)
Sitting	None	2607	1.00‡	
	Sitting	161	0.46	(0.13, 1.56)
Standing	None	2186	1.00‡	
	Standing	582	0.71	(0.46, 1.08)

* Odds ratio
† 95% Confidence interval
‡ Referent group

Table 4.3. Logistic regression model for females who have PMOSs in the top 50

Variable	Group	n	OR*	95% CI†
Race	White	1307	1.00‡	
	Non-white	1323	0.40	(0.33, 0.49)
Age	17-20 years old	483	0.88	(0.66, 1.18)
	21-22 years old	489	0.93	(0.69, 1.24)
	23-26 years old	698	1.00‡	
	27-30.35 years old	413	1.13	(0.83, 1.53)
	30.36-54 years old	415	1.61	(1.20, 2.15)
Maximum Lifting	None	154	1.00‡	
	1-25 lbs	700	2.31	(1.23, 4.34)
	26-50 lbs	331	0.94	(0.51, 1.72)
	51-75 lbs	416	1.04	(0.61, 1.77)
	76-100 lbs	708	1.36	(0.80, 2.31)
	101-125 lbs	182	1.58	(0.87, 2.85)
	126-150 lbs	0		
	151-175 lbs	105	1.48	(0.45, 4.90)
	Raises 267 lbs	36	1.19	(0.46, 6.65)
Pushing/Pulling	None	2006	1.00‡	
	<130 lbs	387	0.91	(0.54, 1.53)
	≥ 130 lbs	166	1.18	(0.43, 3.27)
	ft/lb force	73	0.88	(0.46, 1.69)
	A wrench	0		
Kneeling	None	1405	1.00‡	
	Prolonged periods	920	0.75	(0.50, 1.11)
	While shoveling or lifting	251	1.16	(0.66, 2.07)
	While filing	56	1.27	(0.58, 2.76)
Sitting	None	1919	1.00‡	
	Any sitting	713	0.51	(0.28, 0.94)
Standing	None	1415	1.00‡	
	Any standing	1217	0.83	(0.61, 1.14)

* Odds ratio
† 95% Confidence interval
‡ Referent group

CHAPTER V

DISCUSSION

A. Interpretation of Results

The objective of this study was to create a system for coding occupation withing the Army, by physical tasks, to assess any association with disabling knee injury through a case-control study. The hypothesis that occupational physical tasks are associated with disabling knee injury was supported in this study. Therefore, grouping military occupational specialties (MOSs) by physical tasks is an appropriate way to assess the relationship of occupation and disabling knee injuries. The physical task groupings that were found to have meaningful trends and associations were maximum weight lifted, pushing/pulling, kneeling, sitting, and standing. The MOSs that were grouped together to form these categories can be found in Table A.1 – Table A.5 in the Appendix.

Gender differences were reported in several studies that found that women athletes injure their knees more than men athletes.[5, 9-11] One hypothesis is that differences in injury rates may be due to differences in physiology between the genders.[10, 12-15] Since all analysis in this study was stratified by gender and different MOSs were included in each analysis, differences between men and women should be noted carefully. To properly analyze the differences between genders within the same occupations, a subset of MOSs that includes both men and women should be analyzed.

Race differences were found in models of both genders. Non-white individuals compared to white individuals had reduced odds of a disabling knee injury in both genders. In particular, non-white women compared to white women were less than one

half as likely to have a disabling knee injury (OR=0.40), whereas non-white men compared to white men were 80% as likely to have a disabling knee injury (OR=0.82). This may be due to a couple of reasons. First, there may be physiological differences between the races. Second, this finding may be a reflection of racial prejudices or biases in the system to establish disabilities in the U.S. Army. In other words, non-whites may be less likely to be labeled as disabled compared to whites with a similar knee injury.

Previous military studies found associations with knee injuries and running.[16, 18, 19] Our study did find associations with various levels of running or walking, but there was not a distinct trend in risk of disabling knee injury as amount of running increased. When maximum amount of running/walking was put into the multiple logistic regression models, there were collinearity problems, which resulted in dropping different levels of either running/walking or weight lifted. Even after controlling for all other variables, the odds ratios for distance ran/walked still did not have a distinct trend. This was different than what was found in previous studies, but they did not control for as many occupational physical tasks as we included in our study. Most importantly, amount of weight lifted was not included in any of these previous military studies.

This study found associations between risk of injury and maximum amount of weight lifted. The univariate analysis resulted in a linear trend of increasing odds with increasing weight. After controlling for the other physical factors in the multiple logistic regression models, the trend followed an inverse 'U' shape. For men, the lowest odds of disabling knee injury occurred when lifting 76-100 pounds, whereas higher odds were found when lifting other amounts of weight. For women, the lowest odds of injury occurred at 51-75 pounds, one weight category lower than the category for the men.

This 'U' shape curve may be an indicator for the physical fitness of groups of individuals at the time the weight was lifted. The differences in the genders may be correlated with the physiological differences that have been noted in the literature.[10, 12-15] Soldiers who lift weight on the lower categories may be in worse shape or not as strong as the soldiers who lift weights in the middle categories. For example, Administrative Specialists have sitting in their physical tasks descriptions, which is an indicator of a sedentary job. They also lift 1-25 pounds, which is associated with an increased risk of injury. Because they are sedentary more often, when Administrative Specialists do lift weight, there may be increased odds of injury. Also, as the weight increases past a threshold for each gender, the odds of a disabling knee injury may increase due to physical demands on the knee, regardless of muscle strength or physical fitness.

Another physical task that was analyzed in this study was pushing/pulling. For men, all types of pushing/pulling compared to no pushing/pulling resulted in reduced odds of disabling knee injury. For women, there was a threshold of 130 pounds of pushing/pulling where increased odds of disabling knee injury resulted. Once again, the differences in genders could be due to physiological differences between men and women. Although it is not intuitive that pushing/pulling different weights would lead to a reduced risk of knee injury, it may be an indicator of physical fitness, with those who have jobs descriptions of pushing/pulling being in better shape than those who have jobs without pushing/pulling.

The literature has reported that kneeling is associated with knee injuries.[3,4] This study confirms that kneeling is associated with increased odds of disabling knee injury after controlling for other physical tasks. For men, individuals who had occupational

tasks of kneeling for prolonged periods compared to no kneeling were 1.5 times as likely to have a disabling knee injury. In contrast, women had lower odds of having a disabling knee injury if they had an occupation with prolonged periods of kneeling. All the MOSs in the male model for this category were also in the female model. The odds may be different in the two models because men were asked to do the kneeling more than women. This would need to be assessed further in future analyses to make any type of conclusion.

Men and women with kneeling while shoveling or lifting in the MOS description compared to no kneeling in the description were about 20% more likely to have a disabling knee injury. There were also increased odds of injury if kneeling while filing compared to no kneeling was in the MOS description. These results indicate that kneeling is a risk factor for disabling knee injury.

Sitting and standing in the MOS description was associated with lower odds of disabling knee injury. The odds of injury are more reduced in the sitting compared to no sitting categories than the standing compared to no standing categories. If the job description includes sitting for any amount of time, the job tends to be more sedentary. Therefore, if less strain is being put on the knee, there is less chance that a disabling knee injury will occur. This is also true for standing compared to no standing, except the odds of injury are not reduced as greatly as in the sitting category. This may be because there is some strain on the knee while standing and therefore this physical task is not as protective as sitting.

B. Limitations

Strong associations between the physical tasks in the primary MOS and disabling knee injury were found in this study, but there are some limitations. First, the primary MOS was used rather than the duty MOS. Although preliminary analysis found PMOS and DMOS in a given year to be strongly correlated, the correlation was not perfect.

We are also limited in our knowledge of what physical tasks individuals actually perform. The primary MOS was used to find physical tasks, which were used for grouping individuals. Although certain tasks were defined in the MOS description, it does not mean that soldiers actually performed any or all of these tasks. Furthermore, none of these tasks may have been performed if the soldier performed a different job than indicated by the PMOS.

Another limitation of this study is that only physical tasks, gender, age and race were included. Disabling knee injuries may be closely related to other factors besides the physical tasks of occupation and the demographic variables. One of these factors could be injury present prior to service. Although the Total Army Injury and Health Outcomes Database has this information, it is missing for many of the soldiers in the pilot study. A second factor could be pay grade or rank of the soldiers. Soldiers with lower rank may be more likely to perform the tasks in their PMOS or DMOS as well as other tasks, which may predict their odds of having a disabling knee injury. A third factor could be non-work related physical activities. Although an injury must occur while working to be considered for disability in the U.S. Army, the injury may have first occurred while performing recreational activities or these activities may have exacerbated an injury that occurred on the job. Either way, it may be a combination of occupational physical tasks

and recreational activities that results in a disabling knee injury. Lastly, we have not accounted for treatment that occurred after injury. The type of treatment received may be directly related to whether a knee injury became a disabling one or whether the soldier could continue to perform his or her job.

There could also be limitations to using the broad definition of disabling knee injury as the dependent variable. There were 11 different disabling knee injuries chosen for this study and they may not all have the same risk factors. Different physical tasks may predict the odds of one type of disabling knee injury over another type.

Lastly, we are partially limited by the study population of U.S. Army enlisted personnel. Although, the U.S. Army employees many individuals of different populations they are unique in at least one aspect. In order to enroll in the U.S. Army, individuals must fall within a narrow age range and pass a physical fitness test. Therefore, the population of individuals found in the U.S. Army may be more physically fit than a comparably aged group in the general U.S. population.

C. Significance

Although there are limitations to this study, it has important public health significance. Disabling injuries result in a loss of a job and may affect the daily lifestyle of the injured individual. Furthermore, the mental health of the injured person may decline if the injury results in depression from the loss of a job and physical functioning. These factors in turn may affect the entire family unit.

Also, the U.S. Army employs a very large population. Therefore, even if the external validity is not immediate due to differences in the Army population and the

general population, findings on the Army still affect a large number of people. In particular, this study found that there were differences in the risk factors of the models by gender. Future studies need to look at men and women in the same job to assess the effects of gender on disabling knee injury.

When studies, such as this one, find factors that increase the odds of injury, the results can be used to implement prevention. For example, increased odds of a disabling knee injury were found to be associated with most types of kneeling and some levels of lifting weight. These observations could be used to reduce the amount of this activity or to design devices to help reduce the impact on the knee.

Lastly, there are fiscal implications of studying disabling injuries. The U.S. estimated the fiscal impact of physical disability in 1994 was approximately 500 million dollars for disability payments alone.[3] Therefore, if factors increasing the odds of injury are elucidated and prevention is implemented, the costs of these injuries to the U.S. Army could be reduced.

D. Future Recommendations

This study was stratified by gender and only used race, age, and physical tasks of the MOS as independent variables. In future studies other independent variables could be considered as well. These could be pay grade, injuries prior to service, body mass index, height, weight, and recreational activities. Future studies could also consider more specific dependent variables, which in this case would be specific disabling knee injuries. Also, other types of knee injuries that did not cause a disability could be analyzed to

determine the effects of occupational tasks on other knee injuries. Through these studies, the effects of occupational physical tasks on the knee may be better determined.

APPENDIX: PMOSs in the Physical Task Categories

Table A.1. PMOSs in the maximum lifting categories for men and women in the U.S. Army, 1980-1994

Maximum Lifting Category	Men PMOS	Women PMOS
None	00R: Recruiter/Retention NCO 75Z: Personnel Sergeant 91B: Medical Specialist	75Z: Personnel Sergeant 88N: Transportation Management Coordinator 91B: Medical Specialist
1-25 lbs	71L: Administrative Specialist 75B: Personnel Administrative Specialist 96B: Intelligence Analyst	71D: Legal Specialist 71L: Administrative Specialist 73C: Finance Specialist 75B: Personnel Administrative Specialist 75C: Personnel Management Specialist 75D: Personnel Records Specialist 75E: Personnel Actions Specialist 91S: Preventive Medicine Specialist 96B: Intelligence Analyst
26-50 lbs	16S: ~~Man~~ Portable Air Defense System Crewmember 91C: Practical Nurse 94B: Food Service Specialist	71G: Patient Administration Specialist 91C: Practical Nurse 91D: Operating Room Specialist 91E: Dental Specialist 91R: Veterinary Food Inspection Specialist 93P: Aviation Operations Specialist 94B: Food Service Specialist
51-75 lbs	13F: Fire Support Specialist 16P: CHAPARRAL Crewmember 31U: Signal Support Systems Specialist 52C: Utilities Equipment Repairer 55B: Ammunition Specialist 74C: Record Telecommunications Operator-Maintainer 91A: Medical Equipment Repairer	31U: Signal Support Systems Specialist 55B: Ammunition Specialist 71M: Chaplain Assistant 74C: Record Telecommunications Operator-Maintainer 91A: Medical Equipment Repairer 91K: Medical Laboratory Specialist 91P: Radiology Specialist 98C: Signals Intelligence Analyst
76-100 lbs	13E: Cannon Fire Direction Specialist 19D: Cavalry Scout 31C: Radio Operator-Maintainer 31R: Multichannel Transmission Systems Operator-Maintainer 92A: Military Police 92A: Automated Logistical Specialist 95B: Military Police 98G: Voice Interceptor	31C: Radio Operator-Maintainer 31L: Cable Systems Installer-Maintainer 31R: Multichannel Transmission Systems Operator-Maintainer 74B: Information Systems Operator-Maintainer 92A: Automated Logistical Specialist 92Y: Unit Supply Specialist 95B: Military Police 98G: Voice Interceptor

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Table A.1. continued

Maximum Lifting Category	Men PMOS	Women PMOS
101-125 lbs	12B: Combat Engineer 12C: Bridge Crewmember 13B: Cannon Crewmember 19E: M48-M60 Armor Crewman (Reserve Component) 52D: Power Generation Equipment Repairer 63B: Light-Wheel Vehicle Mechanic 63H: Track Vehicle Repairer 63S: Heavy-Wheel Vehicle Mechanic 63T: BRADLEY Fighting Vehicle Systems Mechanic 63W: Wheel Vehicle Mechanic 67N: UH-1 Helicopter Repairer 77F: Petroleum Supply Specialist	52D: Power Generation Equipment Repairer 63B: Light-Wheel Vehicle Mechanic 63H: Track Vehicle Repairer 77F: Petroleum Supply Specialist
126-150 lbs	19K: M1 Armor Crewman 62E: Heavy Construction Equipment Repairer	
151-175 lbs	11B: Infantryman 11C: Indirect Fire Infantryman 11H: Heavy Antiarmor Weapons Infantryman 11M: Fighting Vehicle Infantryman 88M: Motor Transport Operator	88M: Motor Transport Operator
Raises 267 lbs	54B: Chemical Operations Specialist	54B: Chemical Operations Specialist

Table A.2. PMOSs in the pushing/pulling categories for men and women in the U.S. Army, 1980-1994

Pushing/Pulling Categories	Men PMOS	Women PMOS
None	00R: Recruiter/Retention NCO 11B: Infantryman 11C: Indirect Fire Infantryman 11H: Heavy Antiarmor Weapons Infantryman 11M: Fighting Vehicle Infantryman 13B: Cannon Crewmember 13F: Fire Support Specialist 19D: Cavalry Scout 19K: M1 Armor Crewman 31R: Multichannel Transmission Systems Operator-Maintainer 31U: Signal Support Systems Specialist 52C: Utilities Equipment Repairer 52D: Power Generation Equipment Repairer 63B: Light-Wheel Vehicle Mechanic 63H: Track Vehicle Repairer 63T: BRADLEY Fighting Vehicle Systems Mechanic 63W: Wheel Vehicle Mechanic 71L: Administrative Specialist 74C: Record Telecommunications Operator-Maintainer 75B: Personnel Administrative Specialist 75Z: Personnel Sergeant 91A: Medical Equipment Repairer 91B: Medical Specialist 92A: Automated Logistical Specialist 95B: Military Police 96B: Intelligence Analyst 98G: Voice Interceptor	31L: Cable Systems Installer-Maintainer 31R: Multichannel Transmission Systems Operator-Maintainer 31U: Signal Support Systems Specialist 52D: Power Generation Equipment Repairer 63B: Light-Wheel Vehicle Mechanic 63H: Track Vehicle Repairer 71G: Patient Administration Specialist 71L: Administrative Specialist 73C: Finance Specialist 74B: Information Systems Operator-Analyst 74C: Record Telecommunications Operator-Maintainer 75B: Personnel Administrative Specialist 75C: Personnel Management Specialist 75D: Personnel Records Specialist 75E: Personnel Actions Specialist 75Z: Personnel Sergeant 88N: Transportation Management Coordinator 91A: Medical Equipment Repairer 91B: Medical Specialist 91E: Dental Specialist 91P: Radiology Specialist 91R: Veterinary Food Inspection Specialist 91S: Preventive Medicine Specialist 92A: Automated Logistical Specialist 95B: Military Police 96B: Intelligence Analyst 98C: Signals Intelligence Analyst 98G: Voice Interceptor
<130 lbs	12C: Bridge Crewmember 13E: Cannon Fire Direction Specialist 16P: CHAPARRAL Crewmember 16S: Man Portable Air Defense System Crewmember 55B: Ammunition Specialist 77F: Petroleum Supply Specialist 91C: Practical Nurse 94B: Food Service Specialist	55B: Ammunition Specialist 71M: Chaplain Assistant 77F: Petroleum Supply Specialist 91C: Practical Nurse 91K: Medical Laboratory Specialist 92Y: Unit Supply Specialist 93P: Aviation Operations Specialist 94B: Food Service Specialist

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Table A.2. continued

Pushing/Pulling Category	Men PMOS	Women PMOS
≥130 lbs	12B: Combat Engineer 19E: M48-M60 Armor Crewmember (Reserve Component) 54B: Chemical Operations Specialist 63S: Heavy-Wheel Vehicle Mechanic 67N: UH-1 Helicopter Repairer 88M: Motor Transport Operator	54B: Chemical Operations Specialist 88M: Motor Transport Operator 91D: Operating Room Specialist
ft/lb force	31C: Radio Operator-Maintainer	31C: Radio Operator-Maintainer 71D: Legal Specialist
Pushing/pulling a wrench	62E: Heavy Construction Equipment Repairer	

Table A.3. PMOSs in the kneeling categories for men and women in the U.S. Army, 1980-1994

Kneeling Categories	Men PMOS	Women PMOS
None	00R: Recruiter/Retention NCO 12B: Combat Engineer 12C: Bridge Crewmember 13B: Cannon Crewmember 13E: Cannon Fire Direction Specialist 16P: CHAPARRAL Crewmember 16S: Man Portable Air Defense System 19E: M48-M60 Armor Crewman (Reserve Component) 19K: M1 Armor Crewman 31C: Radio Operator-Maintainer 31R: Multichannel Transmission Systems Operator-Maintainer 31U: Signal Support Systems Specialist 52C: Utilities Equipment Repairer 52D: Power Generation Equipment Repairer 54B: Chemical Operations Specialist 55B: Ammunition Specialist 62E: Heavy Construction Equipment Repairer 63B: Light-Wheel Vehicle Mechanic 63H: Track Vehicle Repairer 63S: Heavy-Wheel Vehicle Mechanic 63T: BRADLEY Fighting Vehicle Systems Mechanic 63W: Wheel Vehicle Mechanic 67N: UH-1 Helicopter Repairer 74C: Record Telecommunications Operator-Maintainer 75Z: Personnel Sergeant 88M: Motor Transport Operator 91A: Medical Equipment Repairer 91B: Medical Specialist 91C: Practical Nurse 95B: Military Police 98G: Voice Interceptor	31C: Radio Operator-Maintainer 31L: Cable Systems Installer-Maintainer 31R: Multichannel Transmission Systems Operator-Maintainer 31U: Signal Support Systems Specialist 52D: Power Generation Equipment Repairer 54B: Chemical Operations Specialist 55B: Ammunition Specialist 63B: Light-Wheel Vehicle Mechanic 63H: Track Vehicle Repairer 71D: Legal Specialist 71G: Patient Administrative Specialist 71M: Chaplain Assistant 73C: Finance Specialist 74B: Information Systems Operator-Maintainer 74C: Record Telecommunications Operator-Maintainer 75Z: Personnel Sergeant 88M: Motor Transport Operator 91A: Medical Equipment Repairer 91B: Medical Specialist 91C: Practical Nurse 91D: Operating Room Specialist 91E: Dental Specialist 91P: Radiology Specialist 91R: Veterinary Food Inspection Specialist 91S: Preventive Medicine Specialist 92Y: Unit Supply Specialist 93P: Aviation Operations Specialist 95B: Military Police 98C: Signals Intelligence Analyst 98G: Voice Interceptor
Prolonged periods	71L: Administrative Specialist 75B: Personnel Administrative Specialist 92A: Automated Logistical Specialist	71L: Administrative Specialist 75B: Personnel Administrative Specialist 75C: Personnel Management Specialist 75D: Personnel Records Specialist 75E: Personnel Actions Specialist 92A: Automated Logistical Specialist

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Table A.3. continued

Kneeling Categories	Men PMOS	Women PMOS
While shoveling or lifting	11B: Infantryman 11C: Indirect Fire Infantryman 11H: Heavy Antiarmor Weapons Infantryman 11M: Fighting Vehicle Infantryman 13F: Fire Support Specialist 19D: Calvary Scout 77F: Petroleum Supply Specialist 94B: Food Service Specialist	77F: Petroleum Supply Specialist 91K: Medical Laboratory Specialist 94B: Food Service Specialist
While filing	96B: Intelligence Analyst	88N: Transportation Management Coordinator 96B: Intelligence Analyst

Table A.4. PMOSs in the sitting categories for men and women in the U.S. Army, 1980-1994

Sitting Categories	Men PMOS	Women PMOS
None	11B: Infantryman	31C: Radio Operator-Maintainer
	11C: Indirect Fire Infantryman	31L: Cable Systems Installer-Maintainer
	11H: Heavy Antiarmor Weapons Infantryman	31R: Multichannel Transmission Systems Operator-Maintainer
	11M: Fighting Vehicle Infantryman	31U: Signal Support Systems Specialist
	12B: Combat Engineer	52D: Power Generation Equipment Repairer
	12C: Bridge Crewmember	54B: Chemical Operations Specialist
	13B: Cannon Crewmember	55B: Ammunition Specialist
	13E: Cannon Fire Direction Specialist	63B: Light-Wheel Vehicle Mechanic
	13F: Fire Support Specialist	63H: Track Vehicle Repairer
	16P: CHAPARRAL Crewmember	71D: Legal Specialist
	16S: Man Portable Air Defense System Crewmember	71G: Patient Administration Specialist
	19D: Calvary Scout	71M: Chaplain Assistant
	19E: M48-M60 Armor Crewmember (Reserve Component)	74B: Food Service Specialist
	19K: M1 Armor Crewman	74C: Record Telecommunications Operator-Maintainer
	31C: Radio Operator-Maintainer	77F: Petroleum Supply Specialist
	31R: Multichannel Transmission Systems Operator-Maintainer	88M: Motor Transport Operator
	31U: Signal Support Systems Specialist	91A: Medical Equipment Repairer
	52C: Utilities Equipment Repairer	91B: Medical Specialist
	52D: Power Generation Equipment Repairer	91C: Practical Nurse
	54B: Chemical Operations Specialist	91D: Operating Room Specialist
	55B: Ammunition Specialist	91E: Dental Specialist
	62E: Heavy Construction Equipment Repairer	91K: Medical Laboratory Specialist
	63B: Light-Wheel Vehicle Mechanic	91P: Radiology Specialist
	63H: Track Vehicle Repairer	91R: Veterinary Food Inspection Specialist
	63S: Heavy-Wheel Vehicle Mechanic	91S: Preventive Medicine Specialist
	63T: BRADLEY Fighting Vehicle Systems Mechanic	92A: Automated Logistical Specialist
	63W: Wheel Vehicle Mechanic	92Y: Unit Supply Specialist
	67N: UH-1 Helicopter Repairer	94B: Food Service Specialist
	74C: Record Telecommunications Operator-Maintainer	95B: Military Police
	77F: Petroleum Supply Specialist	98C: Signals Intelligence Analyst
	88M: Motor Transport Operator	98G: Voice Interceptor
	91A: Medical Equipment Repairer	
	91B: Medical Specialist	
	91C: Practical Nurse	
	92A: Automated Logistical Specialist	
	94B: Food Service Specialist	
	95B: Military Police	
	98G: Voice Interceptor	

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Table A.4. continued

Sitting Categories	Men PMOS	Women PMOS
Sitting	00R: Recruiter/Retainer NCO 71L: Administrative Specialist 75B: Personnel Administrative Specialist 75Z: Personnel Sergeant 96B: Intelligence Analyst	71L: Administrative Specialist 73C: Finance Specialist 75B: Personnel Administrative Specialist 75C: Personnel Management Specialist 75D: Personnel Records Specialist 75E: Personnel Actions Specialist 75Z: Personnel Sergeant 88N: Transportation Management Coordinator 93P: Aviation Operations Specialist 96B: Intelligence Analyst

Table A.5. PMOSs in standing categories for men and women in the U.S. Army, 1980-1994

Standing Category	Men PMOS	Women PMOS
None	11B: Infantryman	31C: Radio Operator-Maintainer
	11C: Indirect Fire Infantryman	31L: Cable Systems Installer-Maintainer
	11H: Heavy Antiarmor Weapons Infantryman	31R: Multichannel Transmission Systems Operator-Maintainer
	11M: Fighting Vehicle Infantryman	31U: Signal Support Systems Specialist
	12B: Combat Engineer	52D: Power Generation Equipment Repairer
	12C: Bridge Crewmember	54B: Chemical Operations Specialist
	13B: Cannon Crewmember	63B: Light-Wheel Vehicle Mechanic
	13E: Cannon Fire Direction Specialist	63H: Track Vehicle Repairer
	13F: Fire Support Specialist	71D: Legal Specialist
	16P: CHAPARRAL Crewmember	71G: Patient Administration Specialist
	16S: Man Portable Air Defense System Crewmember	73C: Finance Specialist
	19D: Cavalry Scout	74B: Food Service Specialist
	19E: M48-M60 Armor Crewmember (Reserve Component)	75Z: Personnel Sergeant
	19K: M1 Armor Crewman	77F: Petroleum Supply Specialist
	31C: Radio Operator-Maintainer	88M: Motor Transport Operator
	31R: Multichannel Transmission Systems Operator-Maintainer	91A: Medical Equipment Repairer
	31U: Signal Support Systems Specialist	91B: Medical Specialist
	52C: Utilities Equipment Repairer	91C: Practical Nurse
	52D: Power Generation Equipment Repairer	91D: Operating Room Specialist
	54B: Chemical Operations Specialist	91E: Dental Specialist
	62E: Heavy Construction Equipment Repairer	91K: Medical Laboratory Specialist
	63B: Light-Wheel Vehicle Mechanic	91P: Radiology Specialist
	63H: Track Vehicle Mechanic	91R: Veterinary Food Inspection Specialist
	63S: Heavy-Wheel Vehicle Mechanic	91S: Preventive Medicine Specialist
	63T: BRADLEY Fighting Vehicle Systems Mechanic	92Y: Unit Supply Specialist
	63W: Wheel Vehicle Mechanic	93P: Aviation Operations Specialist
	67N: UH-1 Helicopter Repairer	98C: Signals Intelligence Analyst
	75Z: Personnel Sergeant	98G: Voice Interceptor
	77F: Petroleum Supply Specialist	
	88M: Motor Transport Operator	
	91A: Medical Equipment Repairer	
	91B: Medical Specialist	
	91C: Practical Nurse	
	98G: Voice Interceptor	

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Table A.5. continued

Standing Category	Men PMOS	Women PMOS
Standing	00R: Recruiter/Retention NCO	55B: Ammunition Specialist
	55B: Ammunition Specialist	71L: Administrative Specialist
	71L: Administrative Specialist	71M: Chaplain Assistant
	74C: Record Telecommunications Operator-Maintainer	74C: Record Telecommunications Operator-Maintainer
	75B: Personnel Administrative Specialist	75B: Personnel Administrative Specialist
	92A: Automated Logistical Specialist	75C: Personnel Management Specialist
	94B: Food Service Specialist	75D: Personnel Records Specialist
	95B: Military Police	75E: Personnel Actions Specialist
	96B: Intelligence Analyst	88N: Transportation Management Coordinator
		92A: Automated Logistical Specialist
		94B: Food Service Specialist
		95B: Military Police
		96B: Intelligence Analyst

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